

USAAVRADCOM-TR 81-D-27

LEVEL II



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AD A107576

**TEST AND EVALUATION OF IMPROVED AIRCREW
RESTRAINT SYSTEMS**

G. T. Singley III

September 1981

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER USAAVRADCOM TR 81 D-27	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) TEST AND EVALUATION OF IMPROVED AIRCREW RESTRAINT SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G. T. Singley III		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Applied Technology Laboratory, US Army Research and Technology Laboratories (AVRADCOM) Fort Eustis, Virginia 23604		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62209A 1L162209AH76
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE September 1981
		13. NUMBER OF PAGES 354
14. MONITORING AGENCY NAME & ADDRESS, if different from Controlling Office		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Personnel restraint Crashworthiness Crash injury Impact		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) US Army aviation accident data shows that a majority of all injuries in attack helicopters could have been avoided if these aircraft had been equipped with crashworthy seat and restraint systems. The compactness of the cockpit and the close proximity of mission equipment to the aircrew in attack and scout helicopters pose serious crash impact hazards. Although not desirable from a crashworthiness standpoint, operational considerations may dictate that mission equipment and structure be located within the occupant's crash impact motion envelope, particularly for his head. The cockpit can be delethalized further when the improved restraint is complemented by		

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20. Abstract - continued.

padding potential strike surfaces in the cockpit; making contact surfaces frangible; and providing weapon system sights with frangibility, telescoping, and/or swing-away features. This report presents the results of an effort to test and compare the potential of several aircrew restraint systems to reduce the crash impact motion envelope of helicopter aircrewmembers.

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PREFACE

The work described in this report was the result of the participation and cooperation of individuals from several Government and industrial organizations. Participating contractors were:

- Thiokol Corporation, Wasatch Division, Brigham City, Utah — provided the Inflatable Body and Head Restraint System (IBAHRS) test specimens under the terms of Naval Air Development Center Contract N 6229-77-C-0025, jointly funded by ATL and NADC.
- Pacific Scientific Company, Anaheim, California — provided the MIL-S-58095, MIL-R-XXXX, and power haul-back restraint system test specimens under the terms of ATL Contract DAAJ02-79-C-0006.
- Simula, Inc., Tempe, Arizona — instrumented two restraint systems for use in the Civil Aeromedical Institute testing under the terms of ATL Contract DAAJ02-79-C-0016.

Appreciation is extended to the following organizations and individuals for their contributions to this effort:

- Federal Aviation Administration, Civil Aeromedical Institute, Oklahoma City, Oklahoma — Mr. R. F. Chandler provided guidance in furnishing the test sled facility, rigid seat apparatus, and anthropomorphic dummy; conducting the sled crash impact testing; acquiring and reducing all test data; and providing photographic records.
- Aircrew Systems Branch, Naval Air Development Center (NADC), Warminster, Pennsylvania — Mr. J. R. McElhenney, Project Engineer, provided the crash impact sensor and test support for all IBAHRS tests.
- Royal Air Force Institute of Aviation Medicine (IAM), Farnborough, England, United Kingdom — Squadron Leader D. C. Reader provided the rotary-motion, single-point attachment/release buckle manufactured by GQ Ltd.
- US Army Natick Research and Development Command (NARADCOM), Natick, Massachusetts — Mr. T. Judge provided the aircrewman clothing, survival vest, and armor vest.
- Applied Technology Laboratory, US Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, Virginia — Mr. J. Batista and Mr. M. Slye analyzed the high-speed motion picture test coverage and illustrated the occupant motion envelopes. Mr. Kent Smith of the Flight Safety Team of Safety and Survivability coordinated and prepared this report for publication upon the departure of the author from this laboratory.

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INTRODUCTION

BACKGROUND

Accident data from the US Army Safety Center involving 4550 helicopter occupants during the period 1971 through 1976 documents the frequency and severity of head injuries. Head injuries are the leading cause of major and fatal injuries (see Table 1) and account for 31.5 percent of fatalities in all helicopters (see Table 2). Figure 1 summarizes the data in Tables 1 and 2.

Current trends toward cockpit space limitation, pilot night vision and target acquisition displays, and armor panels have increased the potential for helicopter crewmember injury. The proximity of the crewmember to cockpit structure instruments, controls, sights, and armor panels is compounded by structural deformation during the crash impact sequence. The potential for major or fatal crash injury is increased in helicopters equipped with weapon sight systems with an eyepiece that requires the copilot/gunner (CPG) to look into it. Under nap-of-the-earth conditions, the CPG viewing through the sight eyepiece can expect little warning of any impending crash impact and a high likelihood of serious head/neck injury. The Army's "Crash Survival Design Guide" published in 1971¹ shows that the head of a crewmember restrained by a conventional aircrew restraint system (lap belt plus double-strap shoulder harness) will displace approximately 10 inches forward during a forward crash pulse as little as 4g (see Figure 2). The proximity of the upright crewmember's head to cockpit controls/sights/instruments (typically 15 inches or less), forward displacement of the occupant with respect to the seat in mild accidents, forward displacement of the seat, and cockpit structural deformation combine to pose a formidable challenge to the aircraft designer's attempts to provide the required level of crash-worthiness.

MIL-STD-1290² is the Army's standard for the design and qualification of new light fixed- and rotary-wing aircraft crashworthiness. This standard requires that fatalities be prevented and injuries minimized in accidents as severe as the 95th percentile potentially survivable accident illustrated in Figure 3. The 95th percentile potentially survivable longitudinal velocity change of 50 feet per second can cause the seat occupant to experience peak longitudinal decelerations of 30g or higher. The latest edition of the "Aircraft Crash Survival Design Guide"³ presents analytical techniques, concepts, and design test criteria for satisfying MIL-STD-1290; it includes seat, restraint system, protective padding, cockpit controls, and equipment considerations.

¹ Turnbow, J. W., et al, *Crash Survival Design Guide*, Dynamic Science, The AvSer Facility, USAAMRDL TR 71-22, Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia, October 1971, AD 733358.

² Military Standard MIL-STD-1290 (AV), *Light Fixed- and Rotary-Wing Aircraft Crashworthiness*, Department of Defense, Washington, DC, 25 January 1974.

³ *Aircraft Crash Survival Design Guide*, Simula Inc., USARTL TR 79-22 A-E, Applied Technology Laboratory, US Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, Virginia:

Volume I - *Design Criteria and Checklists*, December 1980, AD A093784.

Volume II - *Aircraft Crash Environment and Human Tolerance*, January 1980, AD A082512.

Volume III - *Aircraft Structural Crashworthiness*, August 1980, AD A089104.

Volume IV - *Aircraft Seats, Restraints, Ejectors, and Padding*, June 1980, AD A088441.

Volume V - *Aircraft Postcrash Survival*, January 1980, AD A082513.

PROGRAM OBJECTIVE

Although crewmember strike hazards can be reduced by methods such as removing the contact surface from the strike envelope or using frangible structure/sights/controls, telescoping or collapsing sights and controls, air bags, or padding, there are several restraint system options available that offer improved restraint and strike envelope reduction. These include inertia reel systems as well as an inflatable body and head restraint system (IBAHRS). Aircraft designers and program managers lacked data detailing the relative crashworthiness benefits of these available restraint systems, however. For this reason a program was conducted to compare by dynamic crash impact testing the potential of seven types of restraint systems to reduce the probability of injury to helicopter crewmembers resulting from striking the cockpit interior and/or controls.

TECHNICAL APPROACH

The abilities of the seven candidate restraint systems to limit occupant motion during typical helicopter crash pulses were compared by subjecting an anthropomorphic dummy in a stiff, nonstroking seat to a series of crash input pulses using a horizontal sled impact facility. The testing was designed to investigate the effect that the following key variables had on the occupant strike envelope: crash pulse peak deceleration, rise time, and velocity change; anthropomorphic dummy clothing and equipment; restraint system concept; and seat orientation. Accelerometer, load cell, and high-speed photographic data were analyzed to compare the performance of the systems.

TABLE 1. MAJOR AND FATAL INJURIES AS PERCENTAGES OF TOTAL
(US ARMY AIRCRAFT, 1971-1976) (FROM REFERENCE 3)

Percentage of Injuries (Total Injuries in Parentheses)							
Body Part	Helicopters					FW (104)	All Aircraft (1218)
	UH (678)	OH (271)	CH (70)	AH (93)	All (1114)		
Head	19.6	18.5	22.9	21.5	19.7	19.2	19.6
Face	9.1	9.2	10.0	11.8	9.4	14.4	9.9
Neck	2.5	3.0	1.4	3.2	2.6	0.0	2.4
Upper Extremity	10.9	12.9	17.1	15.1	12.1	11.5	12.1
Thorax	13.7	12.2	7.1	8.6	12.5	19.2	13.0
Abdomen	7.8	5.9	10.0	3.2	7.1	5.8	7.0
Pelvis	3.8	2.6	0.0	1.1	3.0	1.9	2.9
Vertebrae	15.3	19.2	8.6	21.5	16.5	12.5	16.2
Lower Extremity	17.1	16.6	22.9	14.0	17.1	15.4	16.9
Legend	UH - Utility Helicopter OH - Observation Helicopter CH - Cargo Helicopter AH - Attack Helicopter FW - Fixed-Wing Aircraft						

TABLE 2. FATAL INJURIES AS PERCENTAGES OF TOTAL (US ARMY
AIRCRAFT, 1971-1976) (FROM REFERENCE 3)

Body Part	Percentage of Injuries (Total Injuries in Parentheses)						All Aircraft (456)
	Helicopters					FW (53)	
	UH (262)	OH (75)	CH (34)	AH (32)	All (403)		
Head	32.4	25.3	35.3	34.4	31.5	30.2	31.4
Face	4.6	4.0	8.8	6.3	5.0	5.7	5.0
Neck	1.9	6.7	0.0	3.1	2.7	0.0	2.4
Upper Extremity	7.3	6.7	8.8	12.5	7.7	5.7	7.4
Thorax	23.3	22.7	8.8	18.8	21.6	28.3	22.4
Abdomen	11.8	12.0	14.7	6.3	11.7	9.4	11.4
Pelvis	0.8	2.7	0.0	0.0	1.0	0.0	0.9
Vertebrae	7.3	6.7	5.9	0.0	6.5	9.4	6.8
Lower Extremity	10.7	13.3	17.6	18.8	12.4	11.3	12.3
Legend:	UH - Utility Helicopter OH - Observation Helicopter CH - Cargo Helicopter AH - Attack Helicopter FW - Fixed-Wing Aircraft						

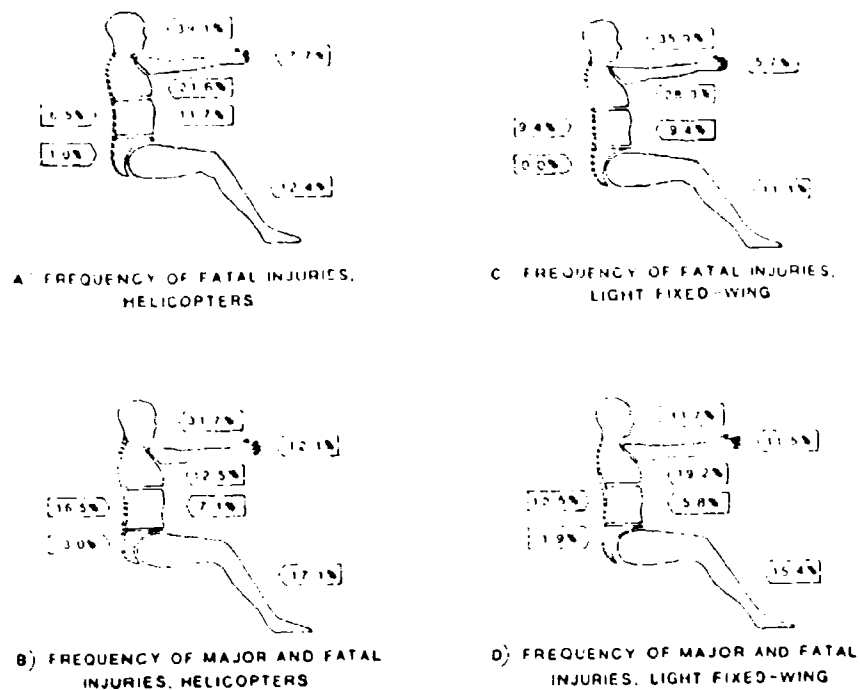


Figure 1. Frequency of injuries to body parts in US Army aircraft accidents, 1971-1976 (from Reference 3).

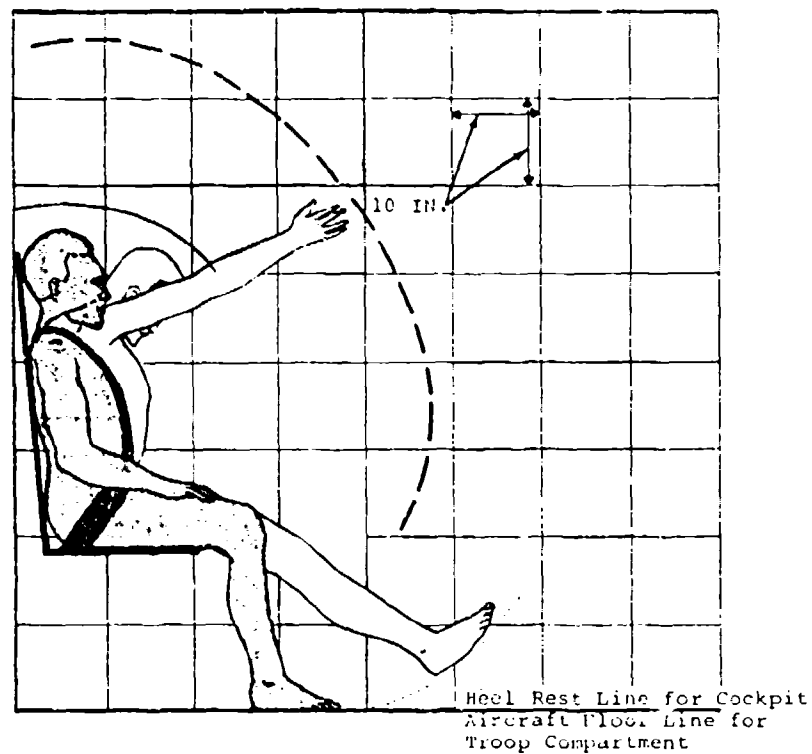


Figure 2. Double shoulder harness with lap belt restraint extremity strike envelope - side view (from Reference 1).

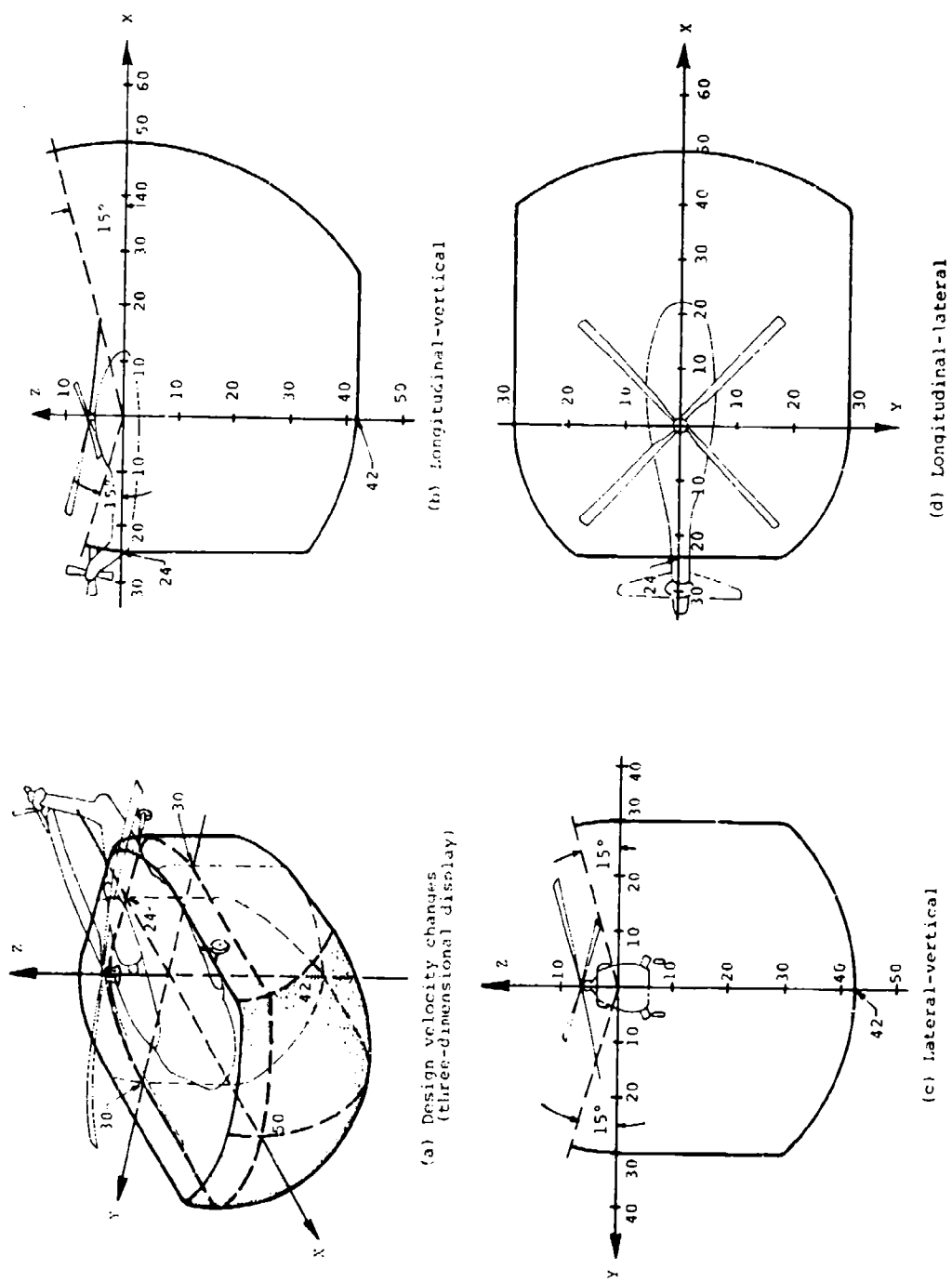


Figure 3. Design velocity change off-axis requirements.

TEST SPECIMENS

Seven types of pilot/copilot restraint systems were crash impact tested and evaluated:

- Type 1 — MIL-S-58095⁴ restraint system (see Figure 4) with MIL-R-8236C⁵ inertia reel.
- Type 2 — Type 1 with a single-strap power haul-back (PHB) reel instead of an inertia reel (see Figure 5).
- Type 3 — Reflected strap shoulder harness restraint of the type proposed in USAAMRDL TR 75-2,⁶ defined in the draft specification MIL-R-XXXX,⁷ and shown in Figure 6.
- Type 4 — Type 3 except with a dual-strap PHB reel in lieu of the two inertia reels (see Figure 7).
- Type 5 — Experimental prototype inflatable body and head restraint system (IBAHRS) shown in Figures 8 and 9.
- Type 6 — Type 5 except with a Type 3 restraint serving as the host restraint for the shoulder strap air bags (see Figure 10).
- Type 7 — Type 1 except the single point attachment/release buckle was replaced with a rotary motion buckle (see Figure 11).

Webbing characteristics for all of the above restraint systems except Type 5 are presented in Table 3. The Type 5 host restraint system consisted of a MS1609-1⁸ shoulder harness, Y-type, and a MS22033-4⁹ aircraft safety lap belt.

⁴Military Specification MIL-S-58095, *Seat System, Crashworthy, Nonejection, Aircrew, General Specification For*, Department of Defense, Washington, DC, August 1971.

⁵Military Specification MIL-R-8236C, *Reel, Shoulder Harness, Inertia Lock*, Department of Defense, Washington, DC, 19 December 1975.

⁶Carr, R. W., and Desjardins, S. P., *Aircrew Restraint System - Design Criteria Evaluation*, Ultrasystems, Inc., USAAMRDL TR 75-2, Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia, February 1975, AD A009059.

⁷Proposed Draft Military Specification MIL-R-XXXX (AV), *Restraint System, Aircrew*, Applied Technology Laboratory, US Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, Virginia, September 1974.

⁸Military Specification MS1609-1, *Shoulder Harness, Y-Type*, Department of Defense, Washington, DC.

⁹Military Specification MS22033-4, *Aircraft Safety Lap Belt*, Department of Defense, Washington, DC.

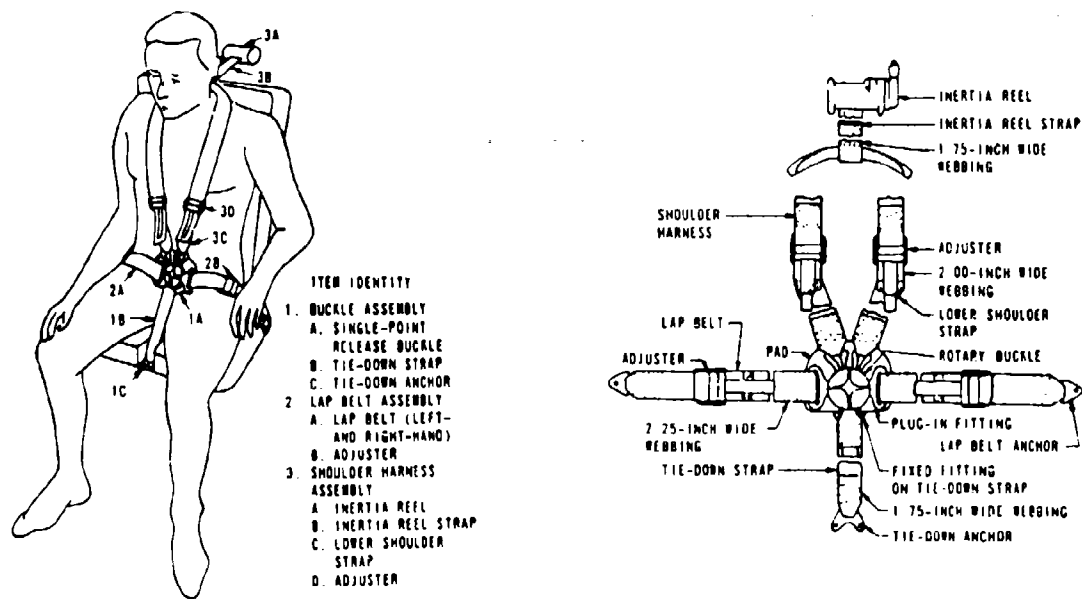
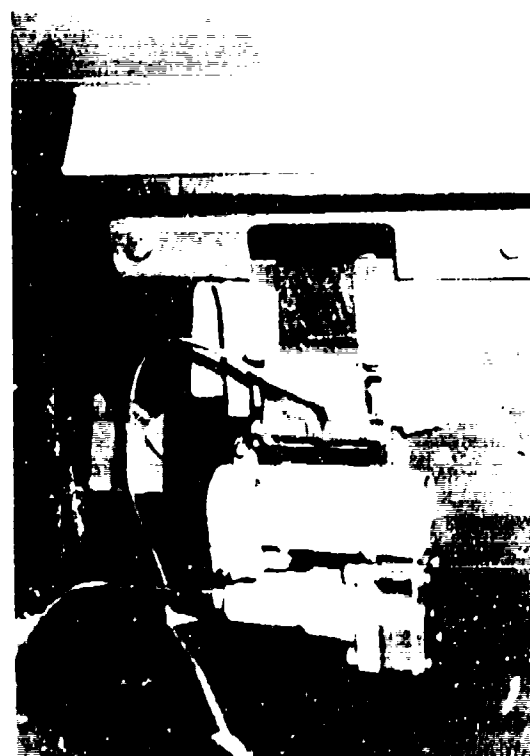


Figure 4. MIL-S-58095 aircrew restraint system.



a. Front view.



b. Rear view.

Figure 5. Type 2 restraint system.

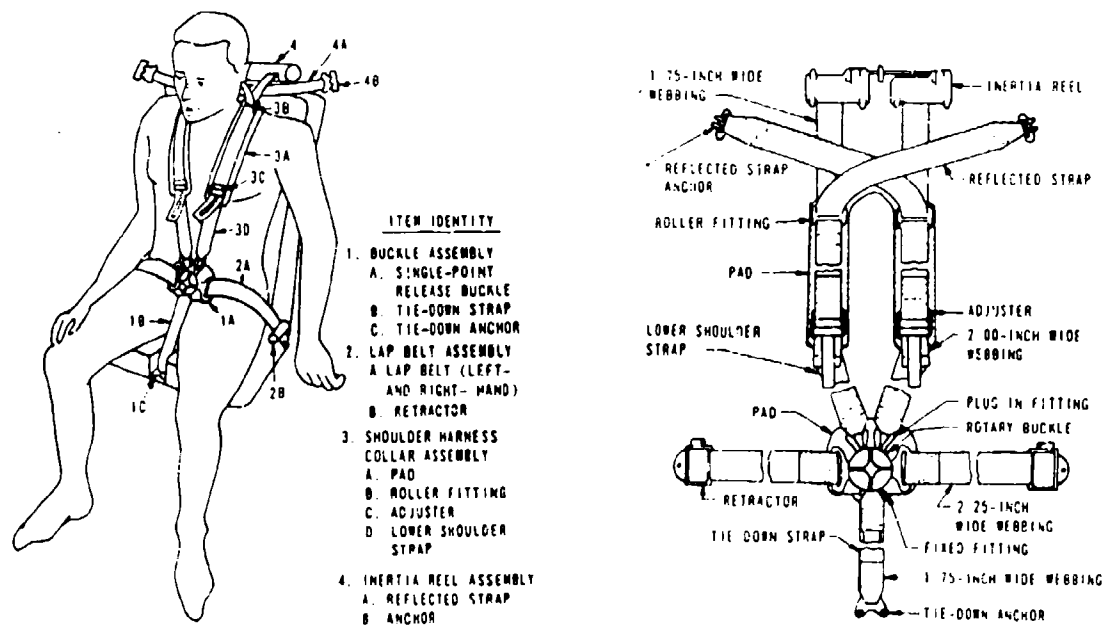


Figure 6. MIL-R-XXXX restraint system, including reflected shoulder straps.

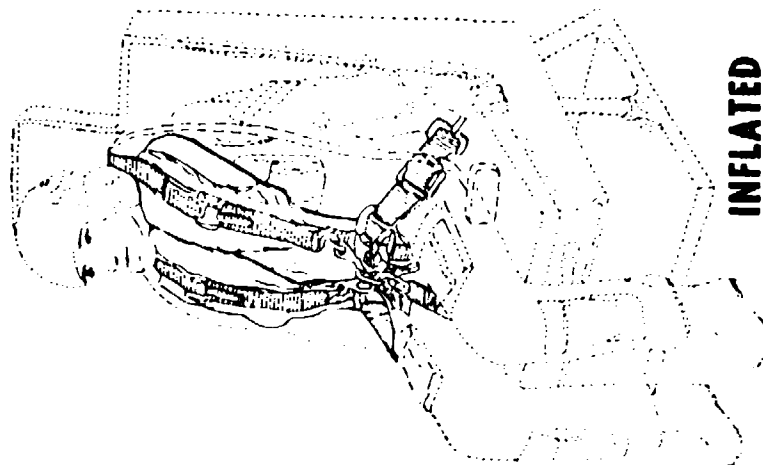


a. Front view.

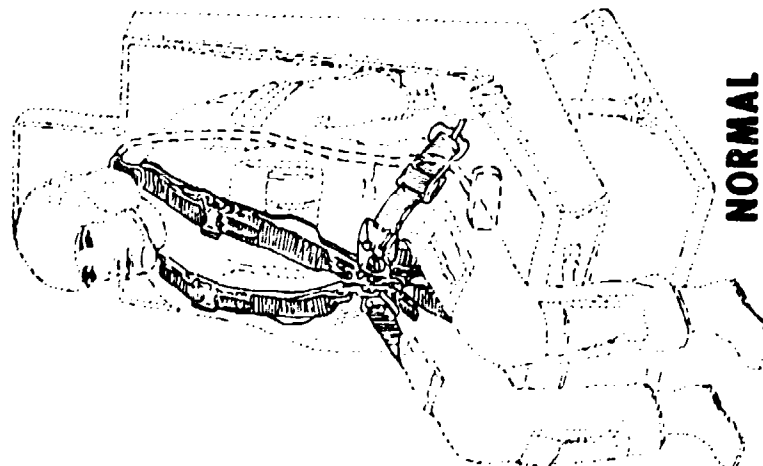


b. Rear view.

Figure 7. Type 4 restraint system.



INFLATED



NORMAL

Figure 8. Inflatable body and head restraint.



a. IBAHRS.



b. Pretest.



c. Posttest.

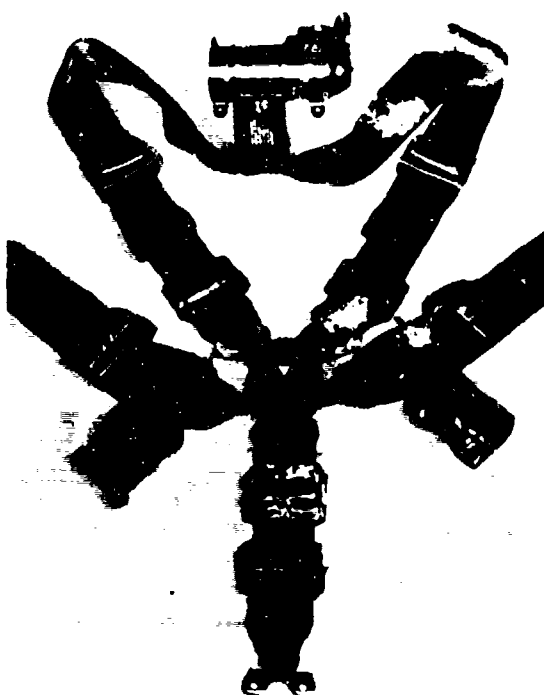
Figure 9. Type 5 restraint system - IBAHRS.



Figure 10. Type 6 restraint system - IBAHRS with MIL-R-XXXX host restraint and air bags unstowed.



a. Back of buckle.



b. Restraint.

Figure 11. Type 7 restraint system - RAF, GQ Ltd system.

TABLE 3. WEBBING CHARACTERISTICS OF RESTRAINT SYSTEMS (except Type 5)

Tests (As Applicable)				Results	Specification Requirements
Width, in.				2-1/4	2-1/4 \pm 1/16
Thickness, 1/1000 in. untreated				0.057	0.055 \pm 0.010
Weave				Passed	Per specification
Yarn	Count or denier	Ply	Turns per in.		
Face and back warp	840	2	2.5	318	318
Binder warp I.D.	840	1	2.5	4	4
Filling picks/in.	1000	2	2.5	23	23
Breaking strength, original				8880	6000 min
Elongation, % at 4000 lb				7.5	7.5-10.0
Color fastness to light				Good	Good
Crocking - dry				8.5	8.5 min
Crocking - wet				8.5	8.5 min
Horizontal burn rate, in./min				0.5	2.5 max

Pacific Scientific Company provided all the restraint systems except the following: Thiokol Corporation provided the Type 5 restraint system and added the inflatable feature to the Type 3 restraint to create the Type 6 restraint; the Royal Air Force Institute of Aviation Medicine provided the Type 7 buckle that was manufactured by GQ Ltd. of the United Kingdom.

The Type 1 restraint is the minimum acceptable required by MIL-S-58095 for US Army forward-facing crewmembers. Type 3 provides improved lateral restraint due to the reflected shoulder straps. Types 2 and 4 were tested to evaluate the potential for reducing the strike envelope by manually activating a ballistic PHB reel. Automatic retraction of the crewmember by a PHB reel activated by crash sensor was rejected. These PHB reels were designed for pre-positioning ejection seat crewmembers and have a retraction time of 0.3-0.4 second, considerably more than the 0.06-second retraction time required if the PHB reel is to be effective in most crashes. An investigation by the US Army Aeromedical Research Laboratory showed that to reduce this retraction time, the torso retraction velocity would have to significantly exceed the current 9-foot-per-second limit established by human tolerance considerations. The PHB reel's potential for this application is that it will be a manually activated tightening device for the CPG in a head-up position and will offer little benefit when the crewmember is in the head-down mode viewing through a sight.

The use of an air bag(s) for the CPG station has potential; however, air bags deflate immediately after inflation, thereby being effective for a single pulse. Also, their application in the cockpit would require considerable research and development. The IBAHRS of Figure 9, however, has more near-term potential. Based on automotive air bag technology, the IBAHRS is being jointly developed by the US Naval Air Development Center and the US Army's Applied Technology Laboratory. It provides increased crash protection when the air bag sewn on the underside of the shoulder strap by the crash impact sensor is inflated, thereby forcing the occupant against the seat back and reducing strike envelope, dynamic overshoot, concentration of strap

load on the body, and rotation and whiplash-induced trauma. Also, if the IBAHRS air bags malfunction, the crewmember still has the protection of the basic (or host) restraint system. One inflator is sewn into each bag and is wired to the crash impact sensor mounted to either the seat or the floor. The inflator is shown in Figure 12. The development of the IBAHRS concept is documented in Reference 10.

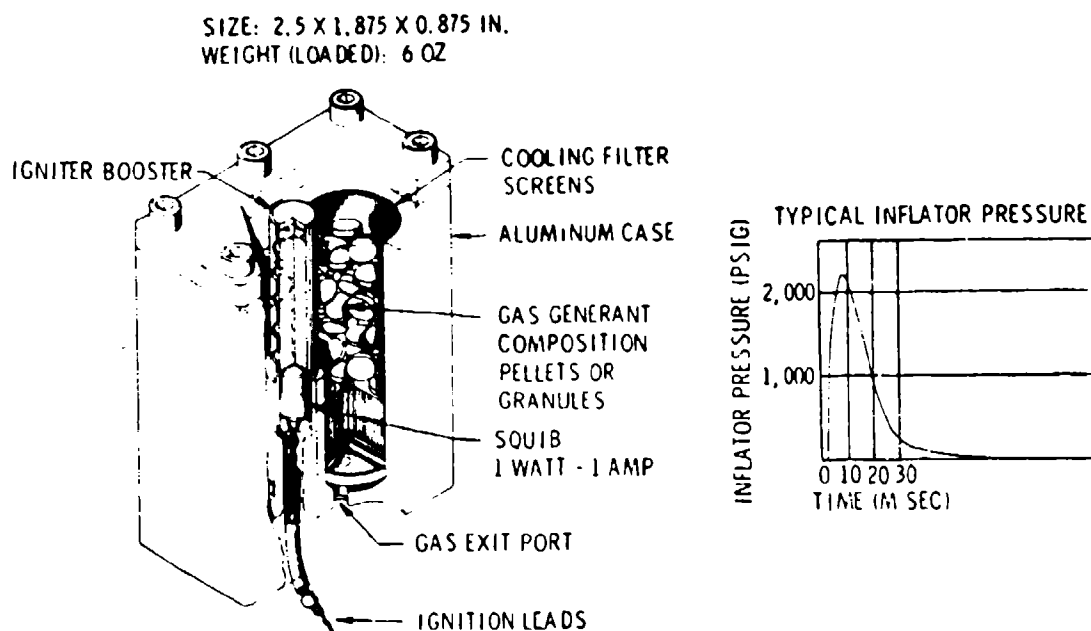


Figure 12. IBAHRS inflator.

¹⁰Schulman, M., and McElhenney, J., *Inflatable Body and Head Restraint*, NADC-77176-40, Naval Air Development Center, Naval Air Systems Command, Washington, DC, September 1977.

CRASH IMPACT SLED TESTING

PROCEDURE

Thirty three crash impact sled tests were performed on the candidate restraint systems at the Federal Aviation Administration's Civil Aeromedical Institute (CAMI). An Alderson Model VIP-95 95th percentile adult male anthropomorphic dummy was used for each test. Dummy clothing and equipment for all tests except numbers 27 and 34 of Table 4 included an APH-5 flight helmet, a flight suit, and boots. Tests 27 and 34 were performed with the addition of an armored vest. The rigid test seat, floor, and rudder pedal geometry is shown in Figure 13. This geometry and the seat pan and back cushions are representative of an attack helicopter. Test impact conditions are given in Table 4.

Data were obtained from accelerometers, webbing load cells, high-speed motion pictures, still photographs, and observation. Triaxial accelerometers were mounted on the head, chest, pelvis, and seat pan bottom surface. Accelerometers were also mounted along the longitudinal axis of the sled, and foot rest reaction loads were recorded. Prior to each test the dummy was positioned in the upright, design eye reference position. The dummy position and strap length were measured to ensure the same body position and restraint system slack prior to each test.

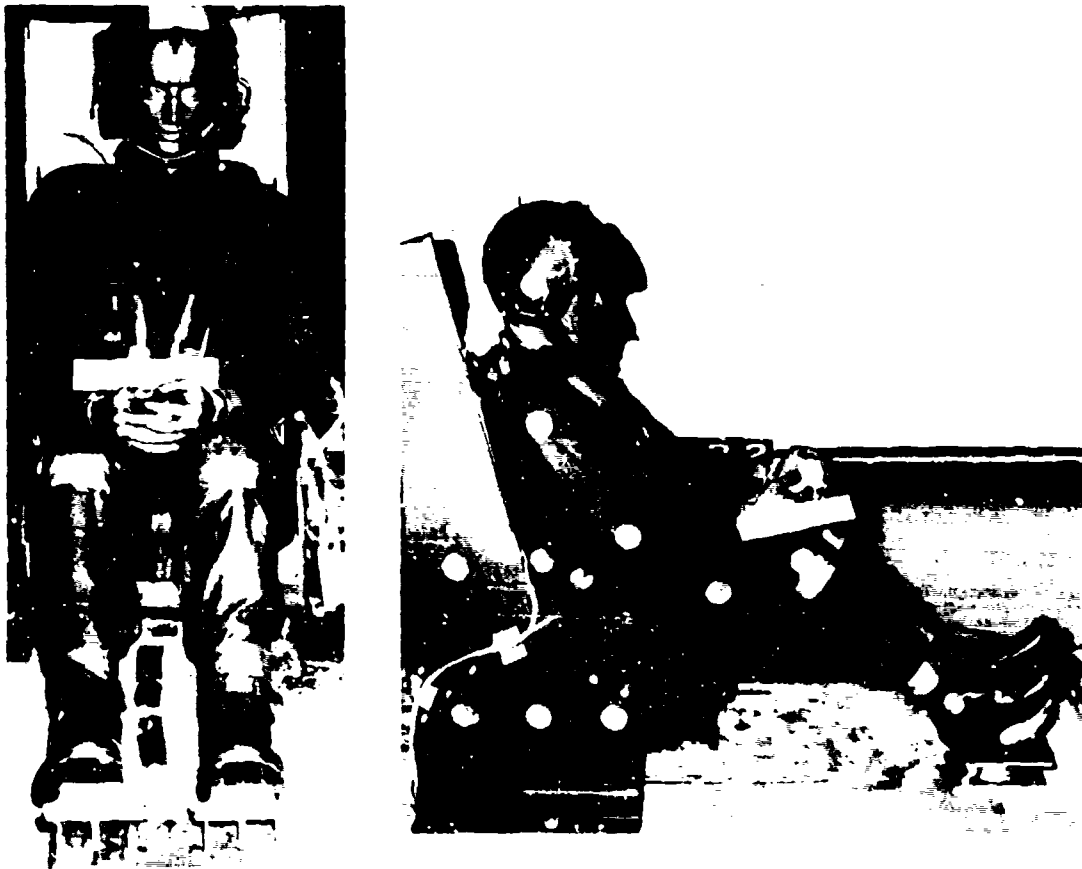


Figure 13. Pretest geometry.

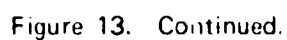


TABLE 4. ATL/CAMI/NADC RESTRAINT SYSTEM TEST DATA

CAMI Test No. A79.	Restraint System		Seat Yaw Angle (deg)	Dummy Weight (lb)	Remarks
	Type	Description			
022	1	MIL-S-58095	50 23 5.4	227	
023	1	MIL-S-58095	85 39 16	227	
024	1	MIL-S-58095	95 50 30	227	
025	1	MIL-S-58095	95 50 30	227	Lap belt fitting failed in "cam-out" mode.
026	1	MIL-S-58095	95 50 30	227	
027	1	MIL-S-58095	95 50 30	244.25	
028	1	MIL-S-58095	95 50 30	227	Lap belt fitting failed by "cam-out".
029	2	MIL-S-58095/PHB	95 50 30	227	
030	4	MIL-R-XXXX/PHB	95 50 30	227	
031	4	MIL-R-XXXX/PHB	50 28 5.4	227	
032	4	MIL-R-XXXX/PHB	85 39 16	227	
033	4	MIL-R-XXXX/PHB	85 39 16	227	
034	4	MIL-R-XXXX/PHB	95 50 30	244.25	
035	3	MIL-R-XXXX	95 50 30	227	
036	1	MIL-S-58095	95 50 30	227	Lap belt fitting tongue failed.
037	4	MIL-R-XXXX/PHB	95 50 30	227	
038	2	MIL-S-58095/PHB	95 50 30	227	Inertia reel failed.
039	3	MIL-R-XXXX	95 50 30	227	
043	1	MIL-S-58095	95 50 30	227	
044	1	MIL-S-58095	95 50 30	227	
045	1	MIL-S-58095	95 50 30	227	Inertia reel strap failed.
046	1	MIL-S-58095	95 50 30	227	
047	7	MIL-S-58095/GQ	95 50 30	227	Inertia reel strap failed.
048	5	IBAHRS	95 50 30	227	Inertia reel failed.
049	5	IBAHRS	95 50 30	227	
050	5	IBAHRS - prepositioned	95 50 30	227	
051	5	IBAHRS - prepositioned	95 50 30	227	
052	5	IBAHRS	95 50 30	227	
053	5	IBAHRS - bags sewn	85 39 16	227	
054	5	IBAHRS - bags sewn	75 34 11	227	
055	5	IBAHRS - bags sewn	50 28 5.4	227	
056	6	MIL-R-XXXX/IBAHRS - bags sewn	85 39 16	227	
057	5	IBAHRS - slack	85 39 16	227	

% - percentile survivable pulse

 ΔV - velocity change, ft/sec

GPK - programmed pulse peak deceleration, g

RESULTS

Accelerometer and strap load cell data for selected tests are compared in Tables 5, 6, and 7 for the 50th, 85th, and 95th percentile potentially survivable impacts respectively. The significant reduction in occupant loading by the IBAHRS reported in Reference 10 and illustrated in Figures 14 and 15 was not noted in these tests and may be attributable to the snug fit of the restraint system used for the tests.

The main benefit of the IBAHRS demonstrated during these tests was the reduction in occupant upper torso, head, and neck motion compared to the other restraint systems (see Figures 16, 17, and 18). Although the occupant head strike envelope was only slightly better with the IBAHRS than with the MIL-R-XXXX/PHB restraint, the IBAHRS has the major advantage of being crash sensor activated. At the 95th percentile pulse level the difference in head strike envelopes of the different restraint systems was less than at the lower impact levels. The Type 7 restraint withstood the 95th percentile survivable pulse with the seat yawed 30 degrees (see test 047 of Table 4).

Malfunctions were experienced with some of the restraint system components. The rotary motion attachment/release buckle failed in a "cam-out" mode when subjected to the 95th percentile potentially survivable pulse when the seat was oriented with a 30-degree yaw. This buckle design had been qualified to MIL-S-58095 in production crashworthy armored crew seat static and dynamic tests and successfully withstood the 0-degree yaw testing. A typical failure is shown in Figure 19. The "cam-out" occurred in the 30-degree yaw tests because the fitting with a rectangular hole rotated both in and out of the plane of the buckle, creating a point load on the buckle dog which precipitated in local plastic deformation of the dog and fitting, permitting the lap belt fitting to slip up and over the dog. This was corrected by rounding the dog and fitting contact edge to allow rotation of the fitting in the plane of the buckle (see Figure 20).

Another problem experienced was the asymmetric deployment of the IBAHRS air bags shown in Figure 21. Although both bags inflated quickly, for the tests with the restraint worn with negligible slack, one of the bags inflated outboard of the strap instead of beneath the chin. In test 057 the IBAHRS was adjusted to allow for more slack, and both bags deployed correctly.

Complete time history plots of load cell and accelerometer data acquired for each test are presented in Appendix A. Dummy strike envelope plots are presented in Appendix B for all tests except -025, -038, and -054.

TABLE 5. ATL/CAMI/NADC RESTRAINT SYSTEM TEST RESULTS

50TH PERCENTILE SURVIVABLE PULSE

 $\Delta V = 28$ fps $G_{PK} = 5.4g$ Yaw = 0°

VIP-95 Dummy 227 lb

Test	Restraint System		
	MIL-S-58095, Test -022	MIL-R-XXXX/PHB, Test -031	IBAHRS,* Test -055
Input pulse: $t_{peak}/\Delta t$.93	.91	.74
Sled G_x	5.8	5.5	6.1
Seat pan G_x	5.8	5.7	6.0
Pelvis:			
G_x	5.5	5.8	7.5
G_z	-2.0	-2.2	0
Chest:			
G_x	7.0	5.0	8.3
G_z	1.5	0	3.4
Head:			
G_{x1}	8.3	7.0	7.5
G_{z1}	7.7	5.5	5.0
G_{x2}	-10.0	-11.5	-13.0
G_{z2}	0	-1.3	-2.5
Straps:			
PRS	300	90	330
PLS	330	160	300
PRL	180	250	300
PLL	210	180	280

* Bags sewn

Legend: G_x = peak longitudinal deceleration, g
 G_{x1} = first peak longitudinal deceleration, g
 G_{x2} = second peak longitudinal deceleration, g
 G_z = peak vertical deceleration, g
 G_{z1} = first peak vertical deceleration, g
 G_{z2} = second peak vertical deceleration, g
PLS = left shoulder strap peak load, lb
PRS = right shoulder strap peak load, lb
PLL = left lap belt strap peak load, lb
PRL = right lap belt strap peak load, lb

TABLE 6. ATL/CAMI/NADC RESTRAINT SYSTEM TEST RESULTS

85TH PERCENTILE SURVIVABLE PULSE

 $\Delta V = 39$ fps $G_{PK} = 16g$ Yaw = 0°

VIP-95 Dummy 227 lb

Test		Restraint System					
		MIL-S-58095, Test -023	MIL-R-XXXX/PHB Test -032	MIL-R-XXXX/PHB, Test -033	IBAHRS,* Test -057	IBAHRS,** Test -053	MIL-R-XXXX /IBARS,** Test -056
Input pulse:							
Sled	G_x	15.0	14.2	14.3	14.7	14.2	14.4
Seat pan	G_x	15.1	14.3	14.9	14.9	14.3	14.6
Pelvis:	G_x	20.0	17.0	19.3	20.0	13.9	15.5
	G_z	-8.7	-9.2	-8.9	-12.2	-7.1	-6.1
Chest:	G_x	17.0	15.5	16.2	17.5	15.4	15.4
	G_z	6.7	-8.2	-3.8	-3.9	-3.0	-3.9
Head:	G_{x1}	19.3	22.5	17.3	19.6	13.9	16.4
	G_{z1}	23.2	16.5	20.4	16.5	15.4	17.3
	G_{x2}	-41.8	-22.5	-20.4	-81.0	-58.9	-69.2
	G_{z2}	15.6	7.0	3.8	22.0	17.3	17.3
Straps:	PRS	1076	330	412	950	937	Lost
	PLS	847	628	678	680	508	Lost
	PRL	692	549	821	1090	697	879
	PLL	761	Lost	817	1170	678	864
	PL Loop	1459	Lost	1625	2277	1364	1723
	PS Sum	1859	943	843	1637	1662	Lost

*Slack with bags stowed

**Bags sewn

Legend: G_x = peak longitudinal deceleration, g
 G_{x1} = first peak longitudinal deceleration, g
 G_{x2} = second peak longitudinal deceleration, g
 G_z = peak vertical deceleration, g
 G_{z1} = first peak vertical deceleration, g
 G_{z2} = second peak vertical deceleration, g
PLS = left shoulder strap peak load, lb
PRS = right shoulder strap peak load, lb
PLL = left lap belt strap peak load, lb
PRL = right lap belt strap peak load, lb

TABLE 7. ATL/CAMI/NADC RESTRAINT SYSTEM TEST RESULTS

95TH PERCENTILE SURVIVABLE PULSE

 $\Delta V = 50$ fps $G_{PK} = 30g$ Yaw = 0°

VIP-85 Dummy 227 lb

		Restraint System					
		MIL-S-58095,	MIL-S-58095/PHB,	MIL-R-XXXX	MIL-R-XXXX/PHB	IBAHRS,*	IBAHRS
Test		Test -024	Test -029	Test -035	Test -030	Test -051	Test -052
Input pulse:							
Sled	G _x	27.5	29.2	29.7	29.8	29.0	28.2
Seat pan	G _x	28.0	29.4	30.0	30.0	28.6	Lost
Pelvis:	G _x	46.8	46.3	45.8	44.5	53.0	50.0
	G _z	-30.0	-31.8	-34.8	Lost	-30.0	-31.2
Chest	G _x	40.3	39.5	43.0	42.8	37.8	42.3
	G _z	15.4	14.0	-12.1	-20.0	-8.9	9.6
Head:	G _{x1}	44.8	43.8	32.0	32.5	31.8	29.0
	G _{z1}	45.8	46.5	40.5	48.0	46.1	50.6
	G _{x2}	-76.3	-112.5	-24.8	-83.3	-107.7	-104.2
	G _{z2}	28.3	44.5	12.0	33.8	43.2	39.0
Straps:	P _{RS}	1560	1615	846	900	2169	1855
	P _{LS}	1450	1528	733	886	1407	1305
	P _{RL}	2190	2302	2285	2336	2783	2076
	P _{LL}	2140	2093	2169	2093	2711	2031
P _L Loop		4312	4438	4465	4403	5498	4086
P _S Sum		2880	3188	1428	1748	3511	3176

*Bags pre-positioned and sewn

Legend: G_x = peak longitudinal deceleration, g
 G_{x1} = first peak longitudinal deceleration, g
 G_{x2} = second peak longitudinal deceleration, g
 G_z = peak vertical deceleration, g
 G_{z1} = first peak vertical deceleration, g
 G_{z2} = second peak vertical deceleration, g
PLS = left shoulder strap peak load, lb
PRS = right shoulder strap peak load, lb
PLL = left lap belt strap peak load, lb
PRL = right lap belt strap peak load, lb

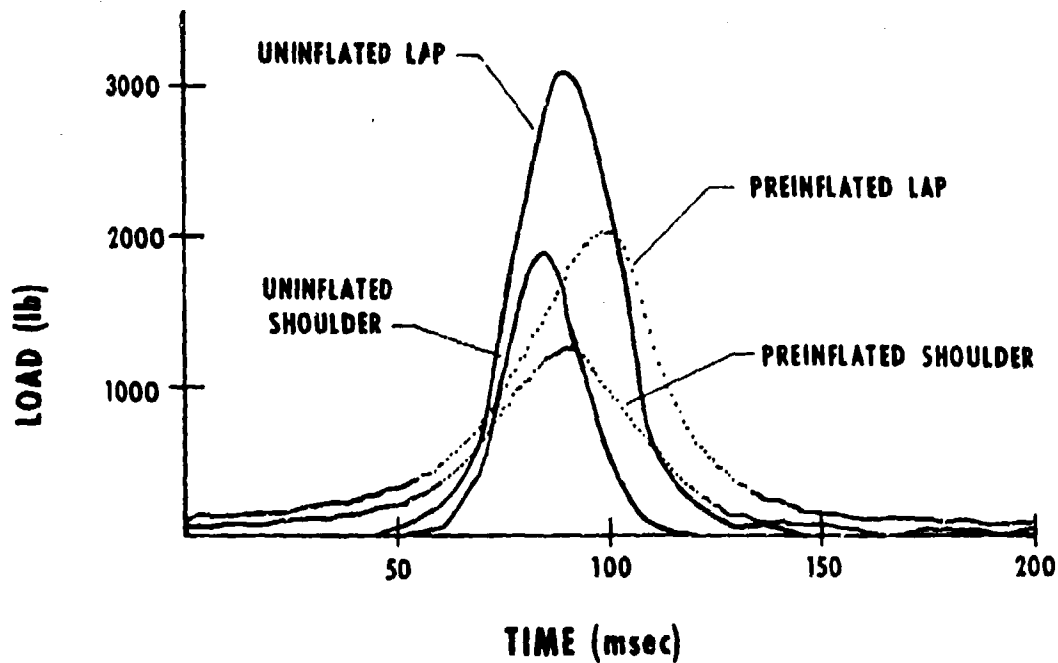


Figure 14. Uninflated versus preinflated restraint with 2-inch shoulder and 1-inch lap belt slack at 15g.

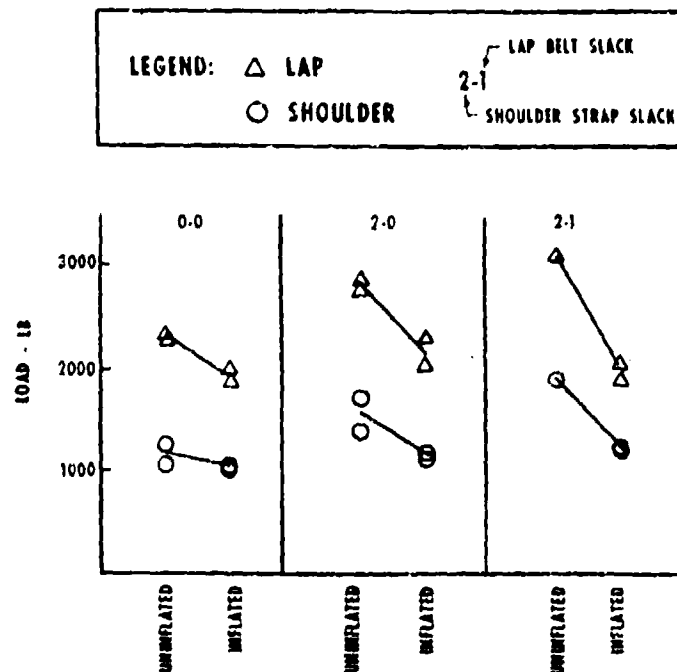


Figure 15. Reduction of restraint loads with inflation for three slack conditions.

PULSE: 50th PERCENTILE SURVIVABLE
 $\Delta V = 28 \text{ FPS}$ $Q_{\text{PEAK}} = 0.4$
 $\text{YAW} = 0^\circ$
DUMMY: VIP-85, 227 LB

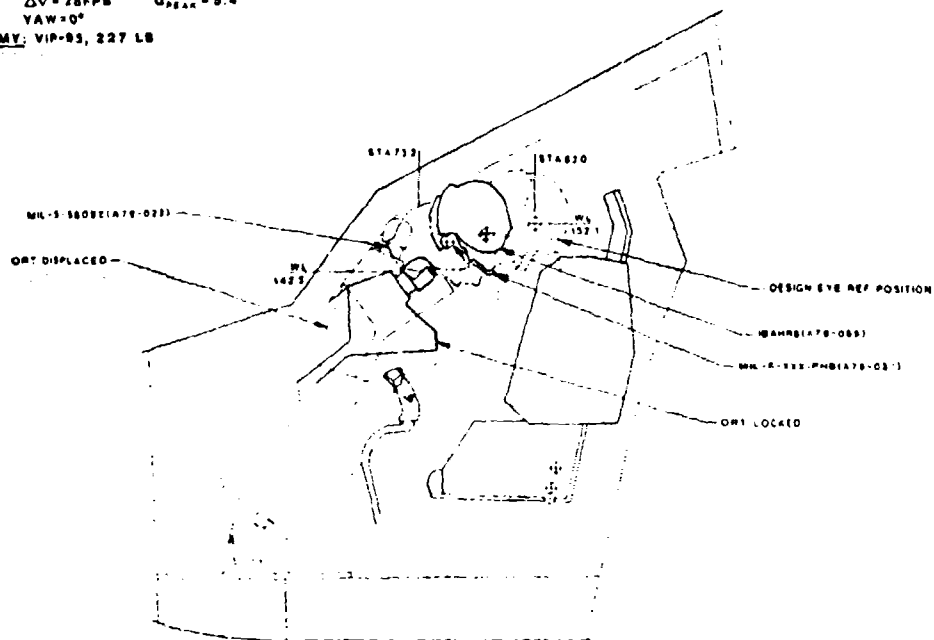


Figure 16. CPG strike envelope comparison (50th percentile survivable pulse).

PULSE: 85th PERCENTILE SURVIVABLE
 $\Delta V = 30 \text{ FPS}$ $Q_{\text{PEAK}} = 1.0$
 $\text{YAW} = 0^\circ$
DUMMY: VIP-85, 227 LB

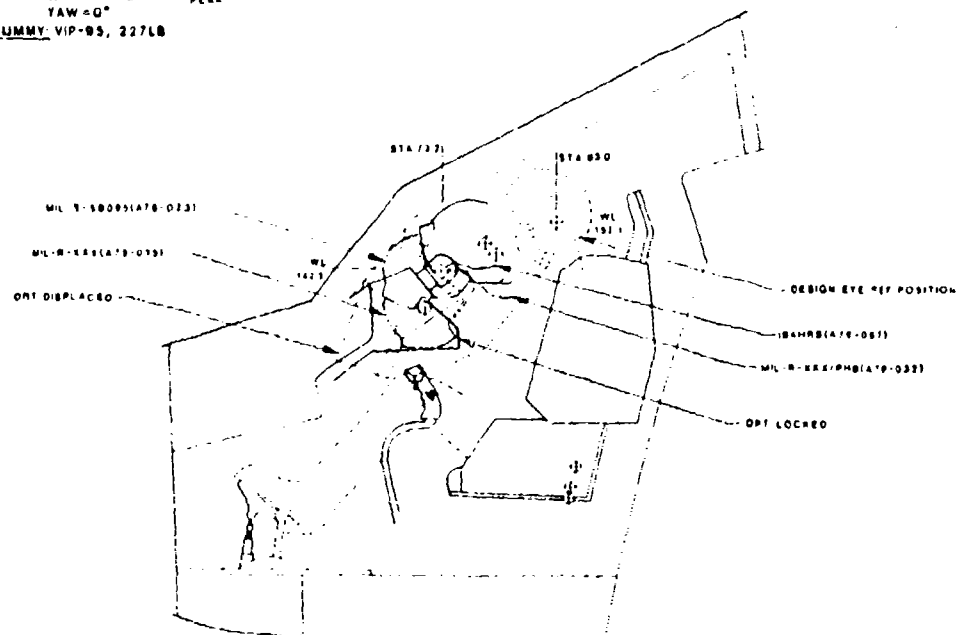


Figure 17. CPG strike envelope comparison (85th percentile survivable pulse).

PULSE: 95th PERCENTILE SURVIVABLE
 $\Delta V = 30 \text{ FPS}$ $G_{\text{PEAK}} = 30$
 YAW = 0°
 DUMMY: VIP-95, 227 LB

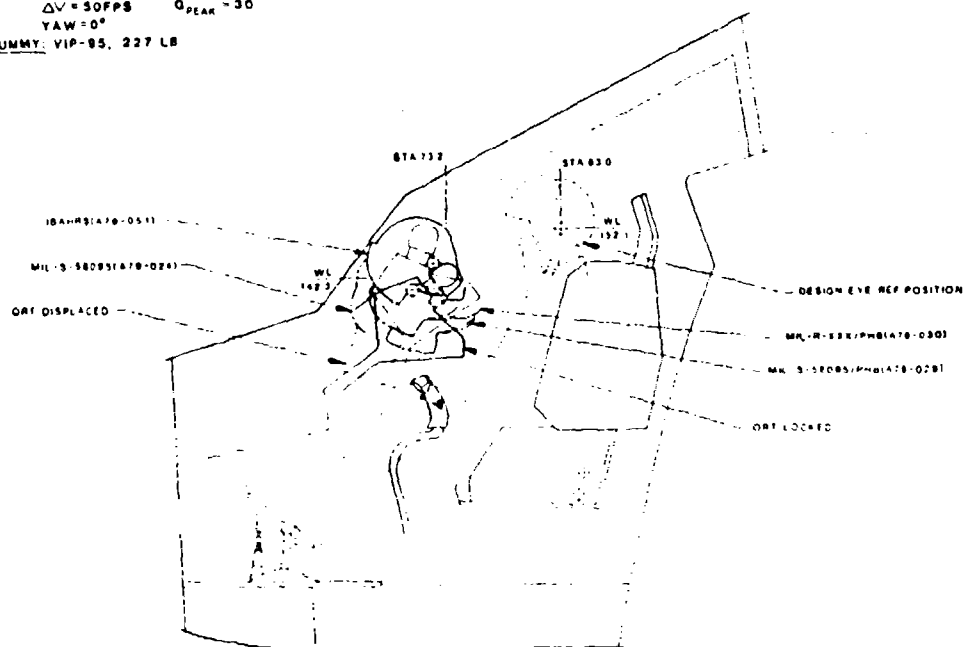


Figure 18. CPG strike envelope comparison (95th percentile survivable pulse).

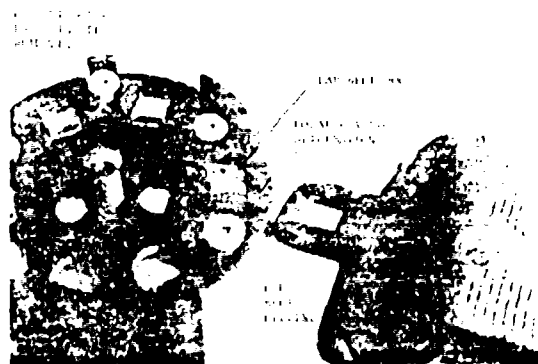
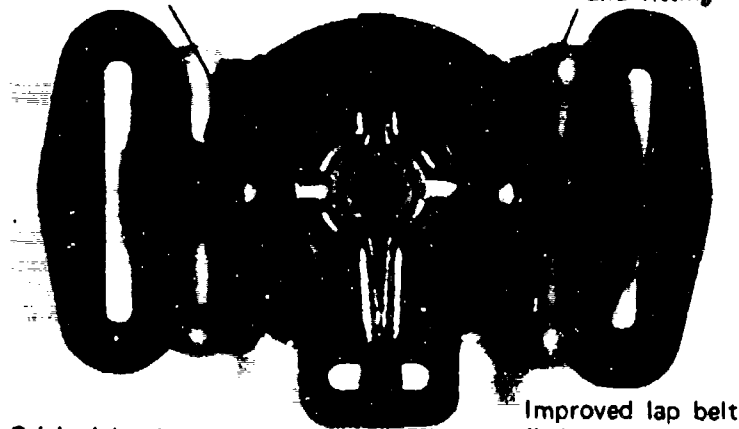


Figure 19. Buckle failure.

Rectangular dog
and fitting

Rounded dog
and fitting



a. Buckle engaged.

Original lap belt
design

Improved lap belt
fitting and buckle
design

b. Buckle unengaged.



Figure 20. Buckle modification.



Figure 21. IBAHRS asymmetric deployment.

CONCLUSIONS AND RECOMMENDATIONS

Both the IBAHRS and PHB reel features will decrease the occupant head motion envelope in crash impacts as severe as the 95th percentile potentially survivable helicopter accident pulse; however, because it is crash sensor activated, the IBAHRS is preferable. This level of protection is based on a rigid seat such as the one used in these tests. Seat forward displacement during a crash characteristic of crash force attenuating seats which stroke in the forward direction will compromise the potential protection of any restraint system.

The Army and Navy are continuing the development of the IBAHRS for potential application to attack and scout helicopters. Notwithstanding the benefits of the IBAHRS, future combat helicopters should be designed to remove the occupant strike hazard where operational considerations permit. In addition, any sights and/or cyclic sticks which must remain within the crew-member's strike envelope should be collapsible, crushable, or telescoping. The detailed cockpit delethalization design criteria of Volume IV of the "Aircraft Crash Survival Design Guide"³ should be followed.

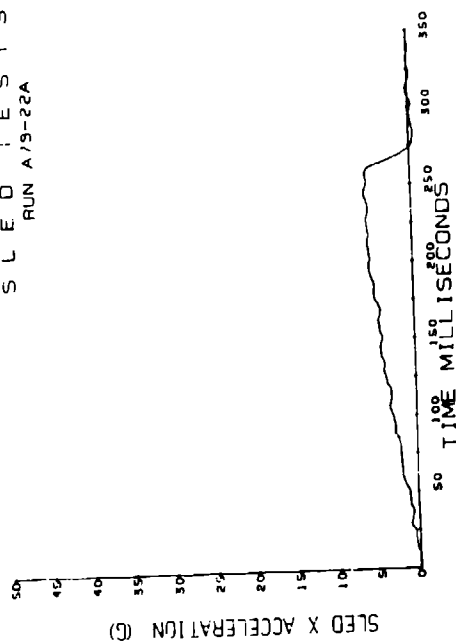
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APPENDIX A ATL/CAMI/NADC RESTRAINT SYSTEM TEST DATA

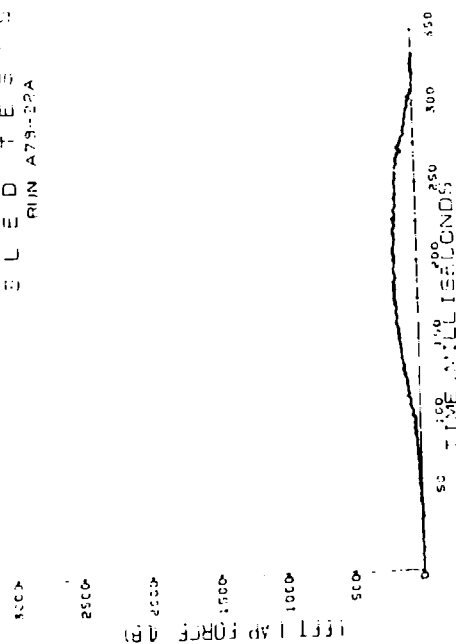
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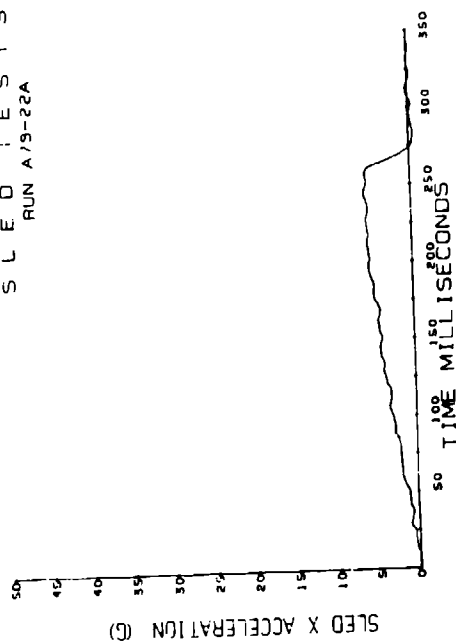
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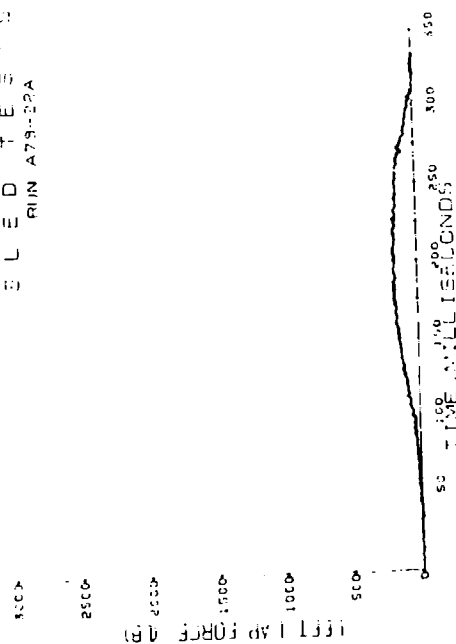
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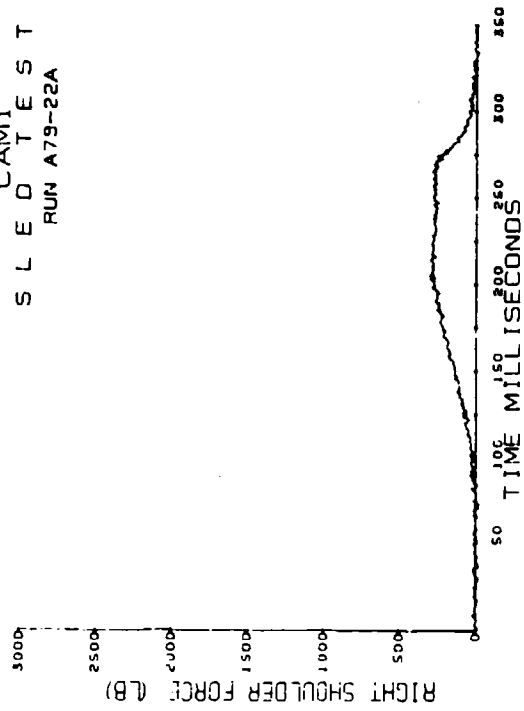


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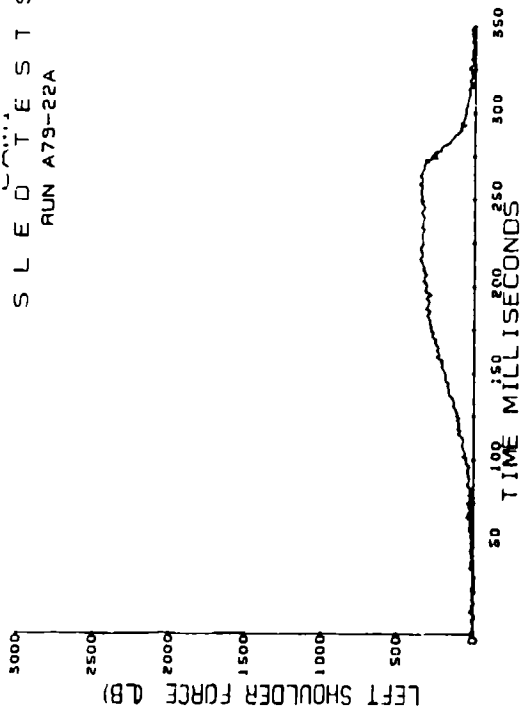
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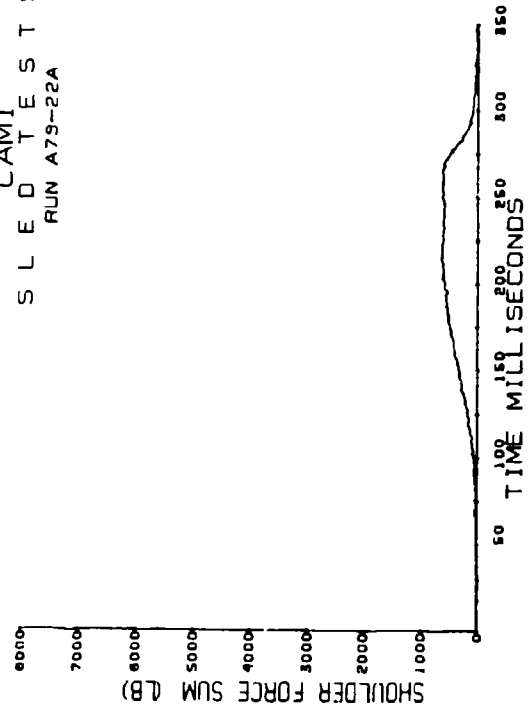
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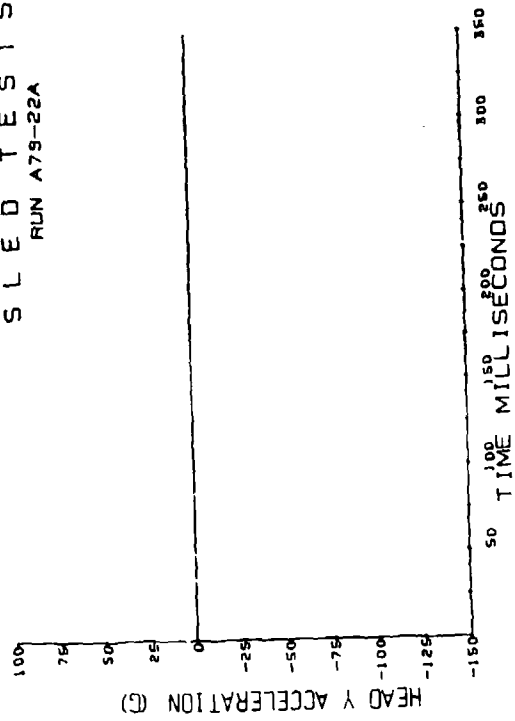
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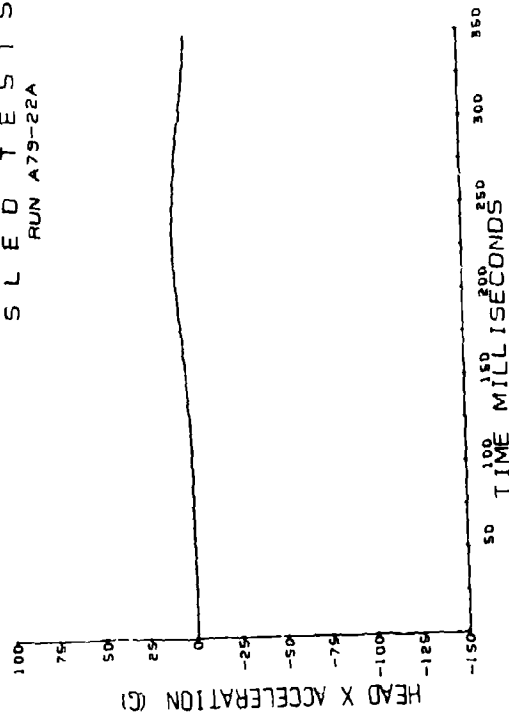
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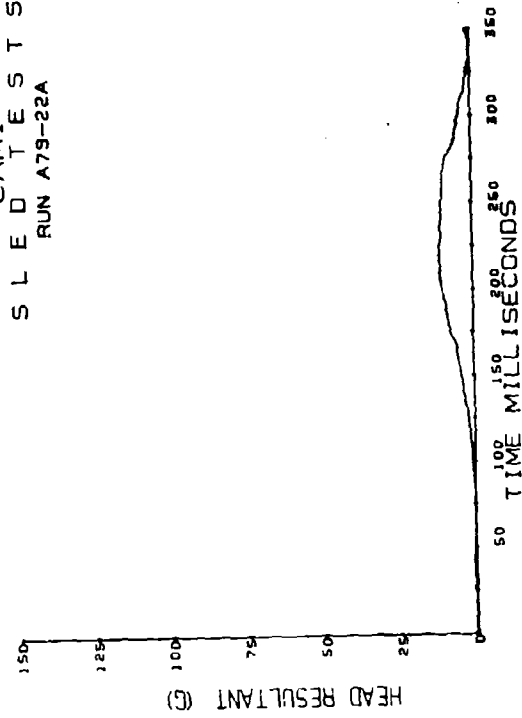
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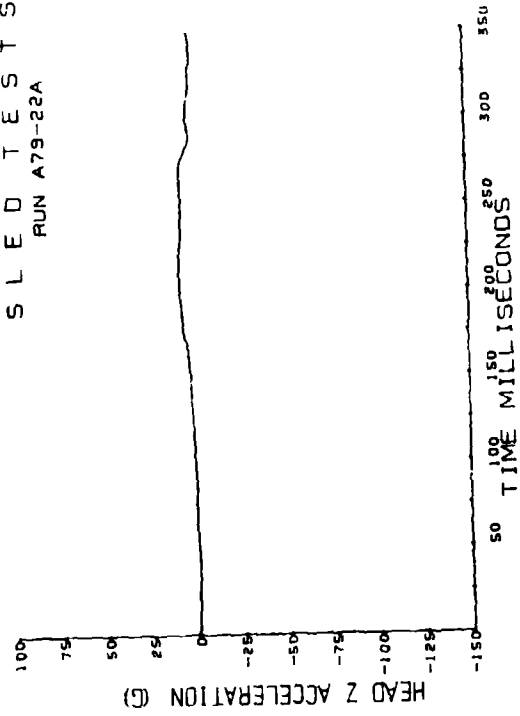
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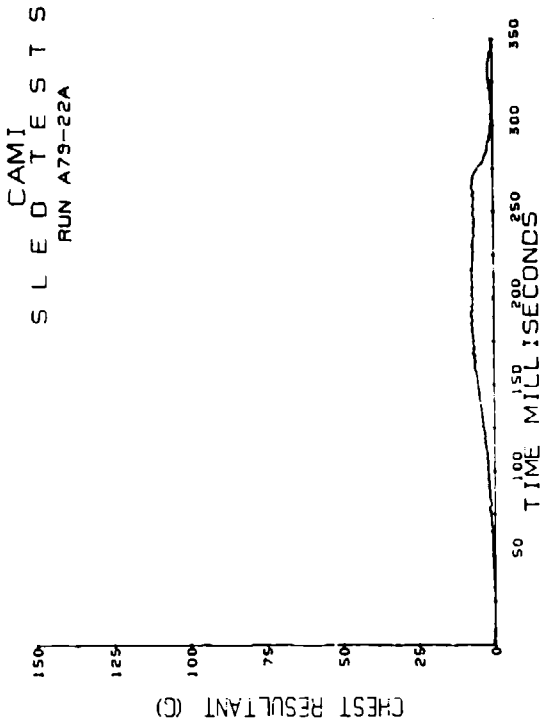
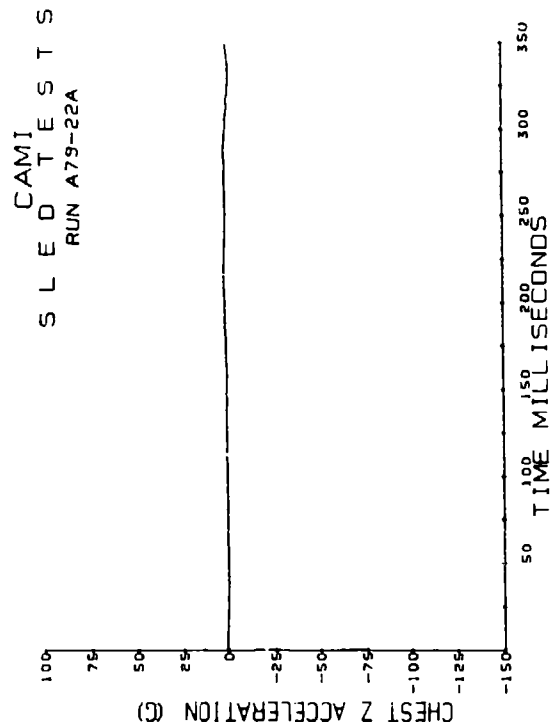
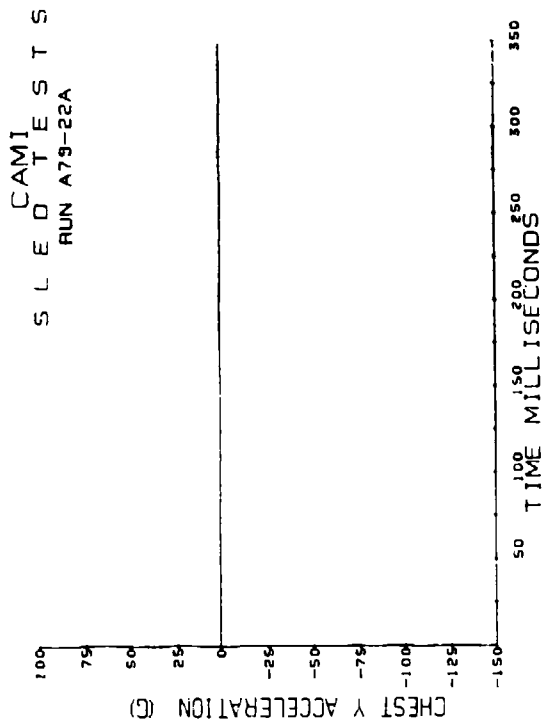
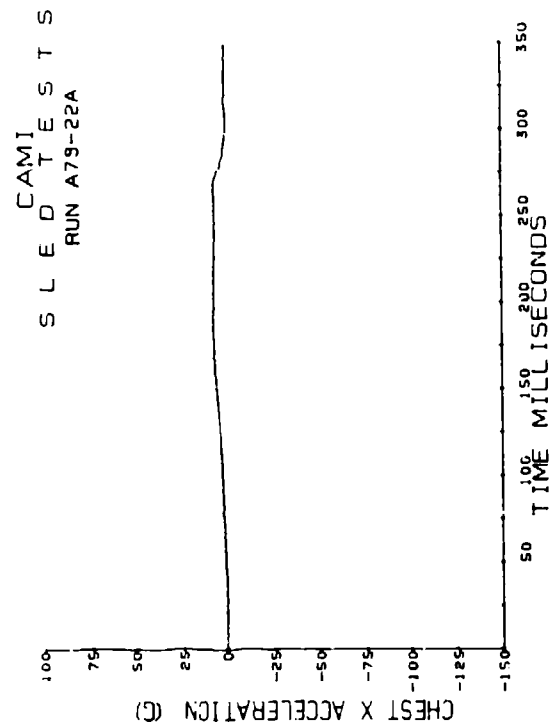


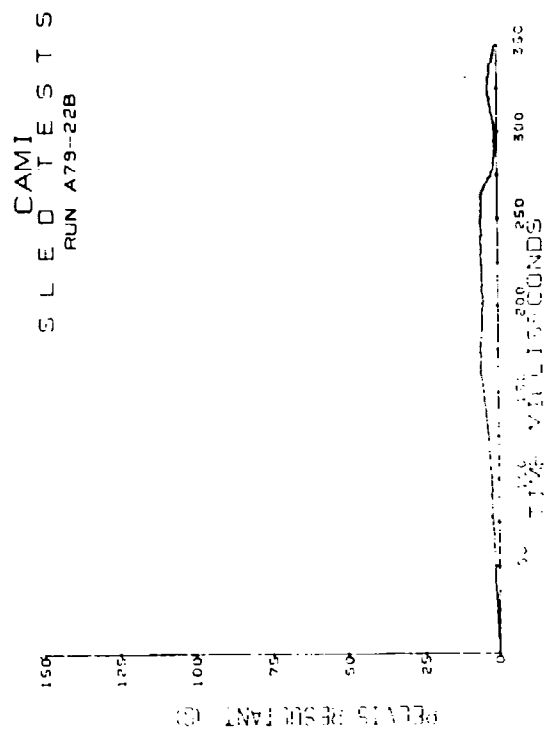
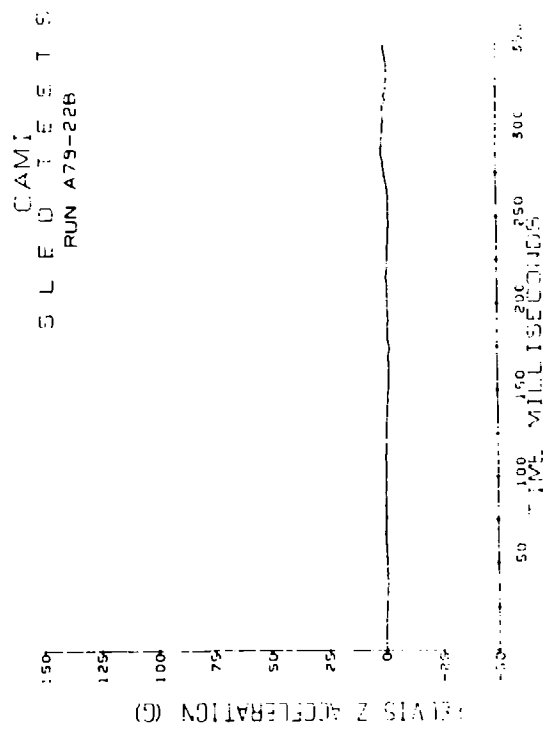
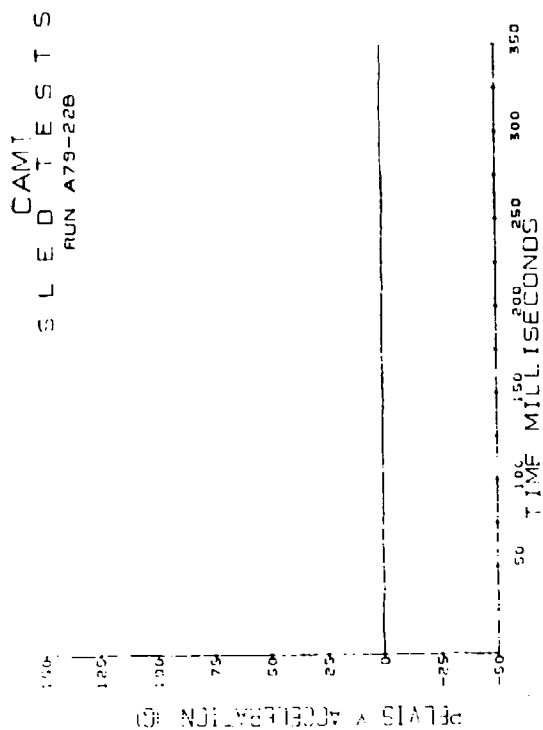
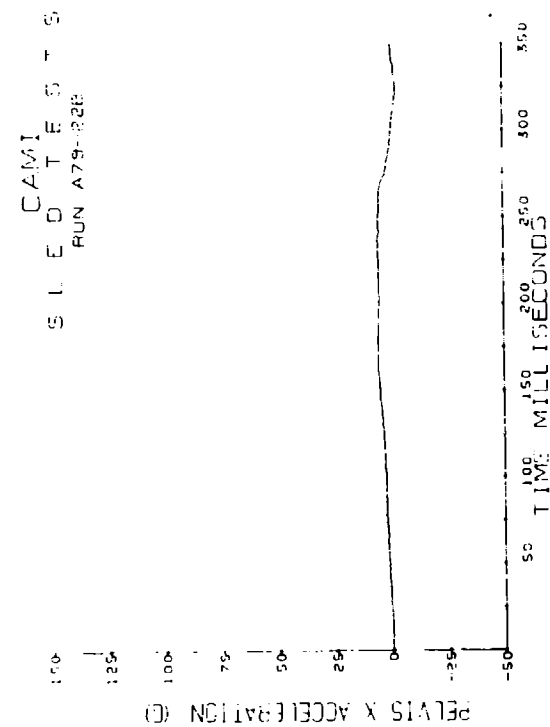
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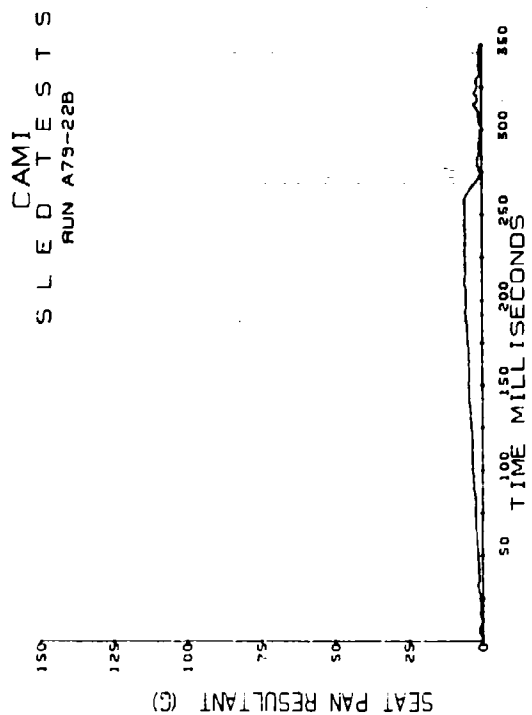
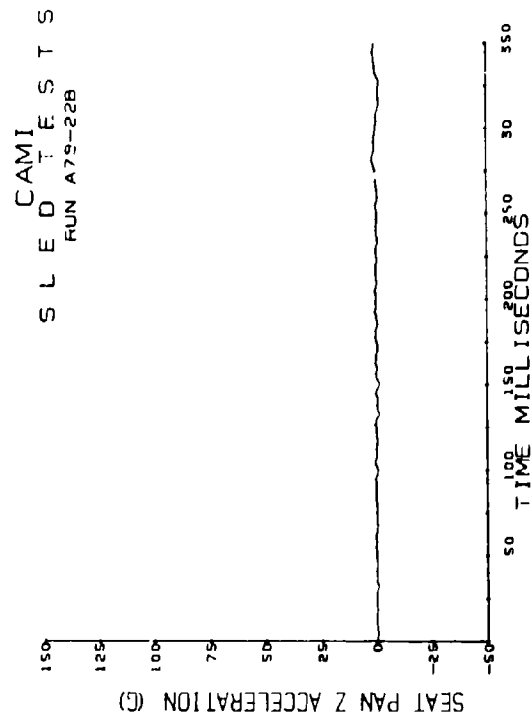
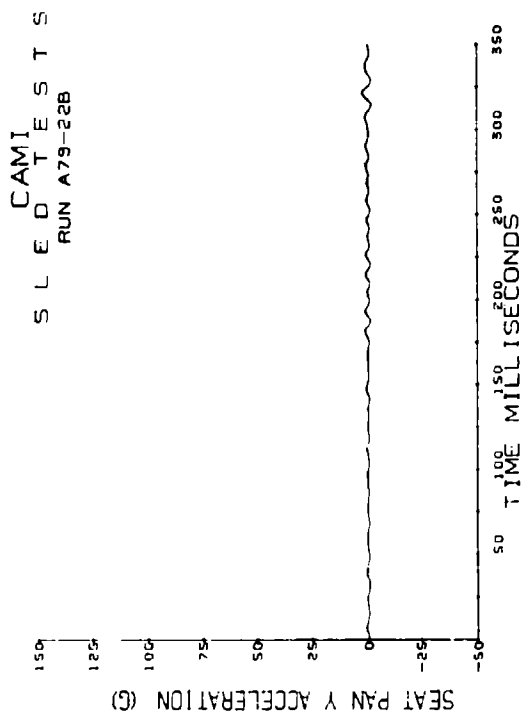
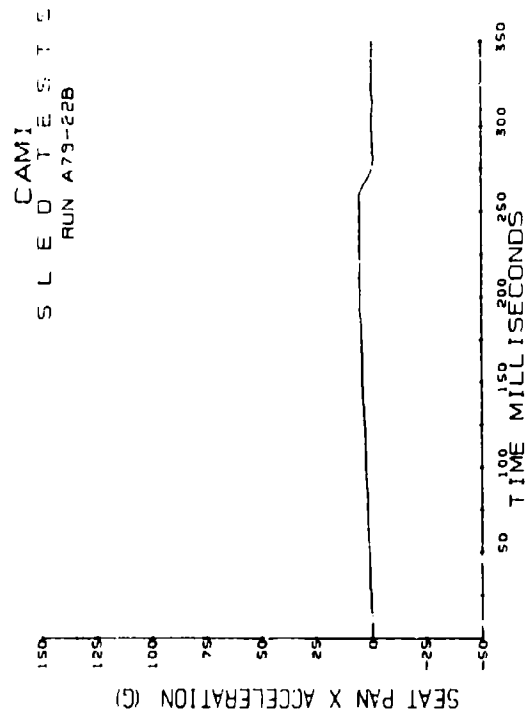


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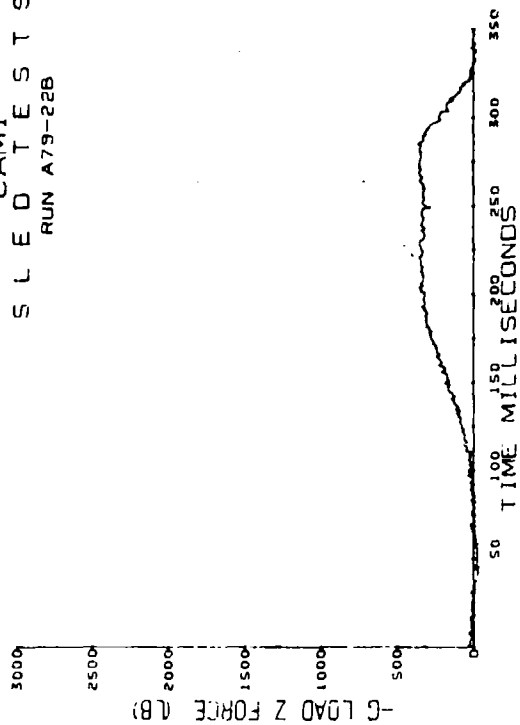




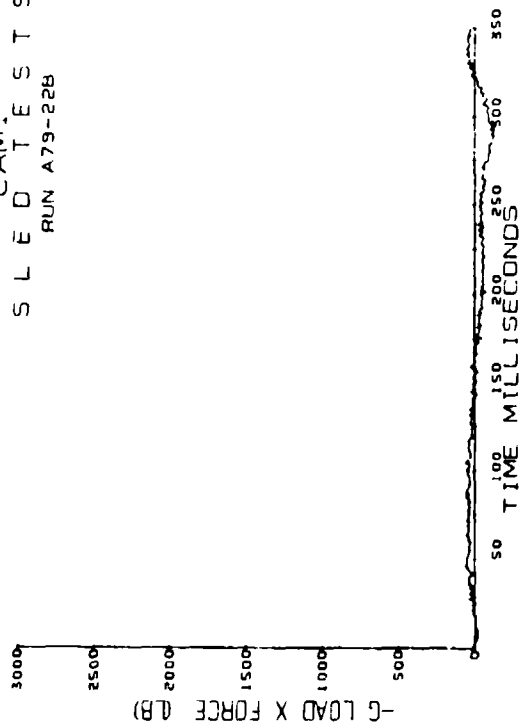




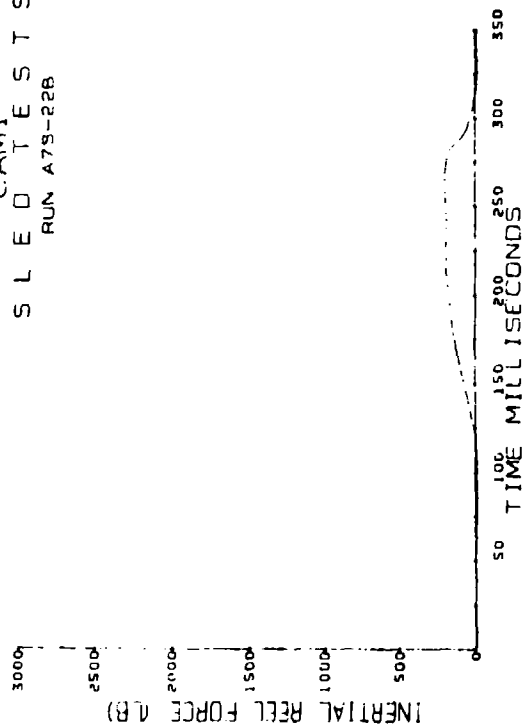
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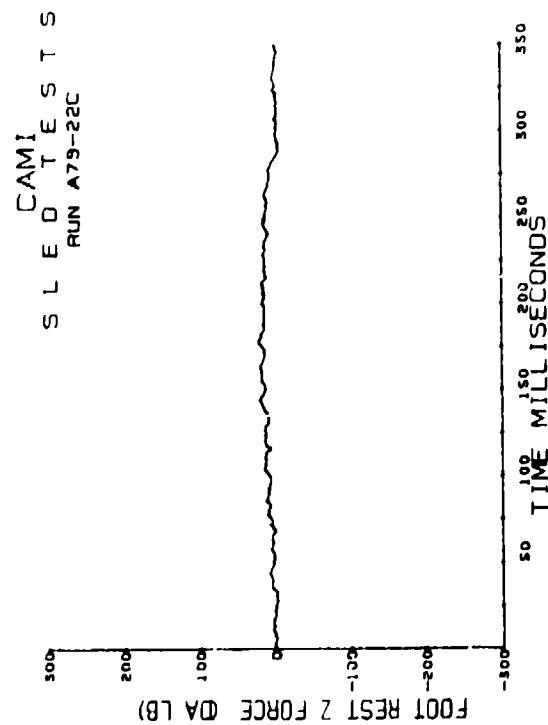
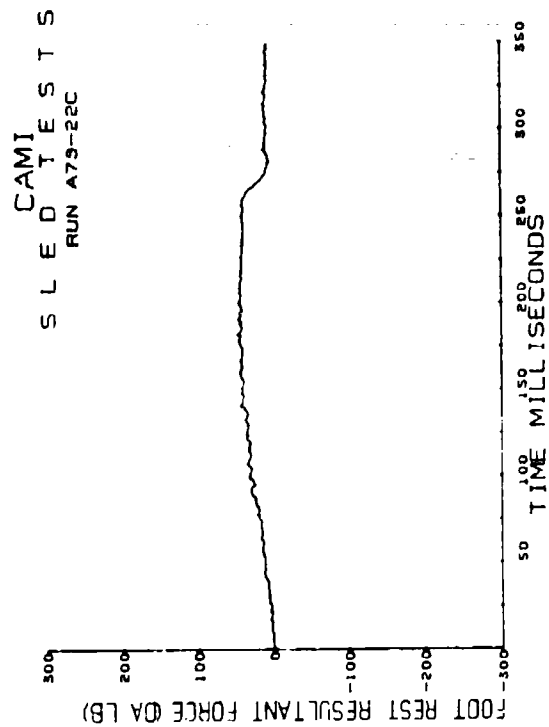
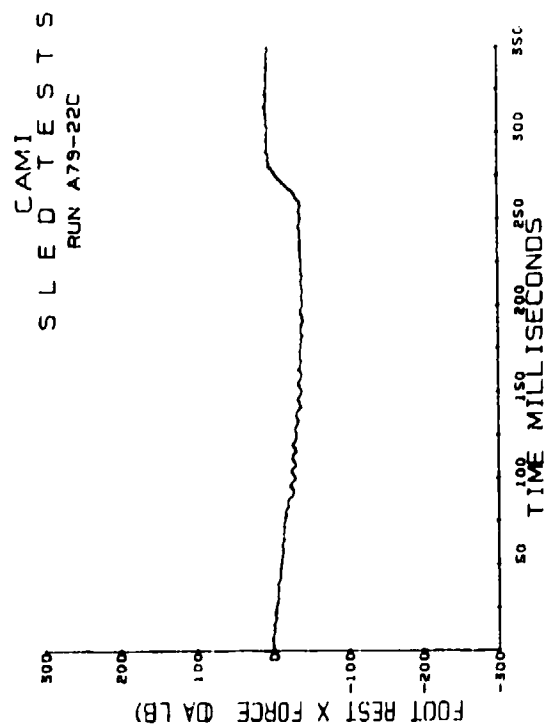
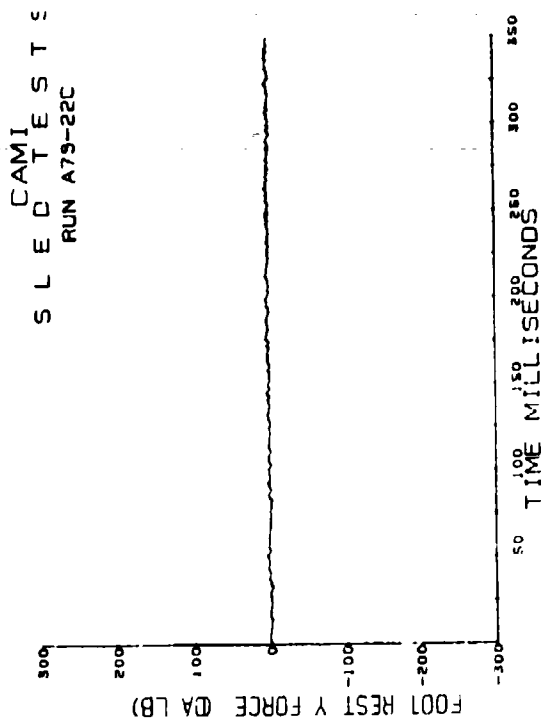


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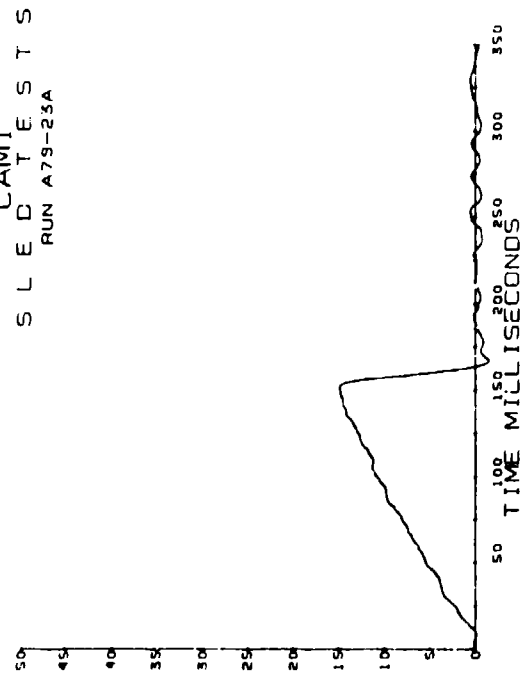
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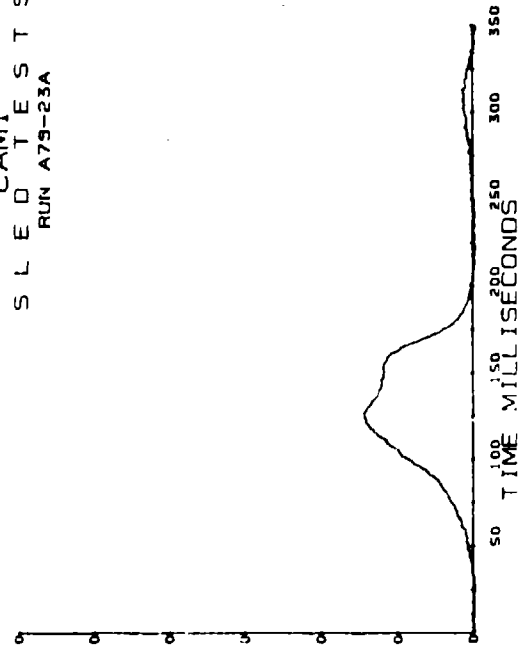


CAMI
S L E D T E S T S
RUN A79-23A

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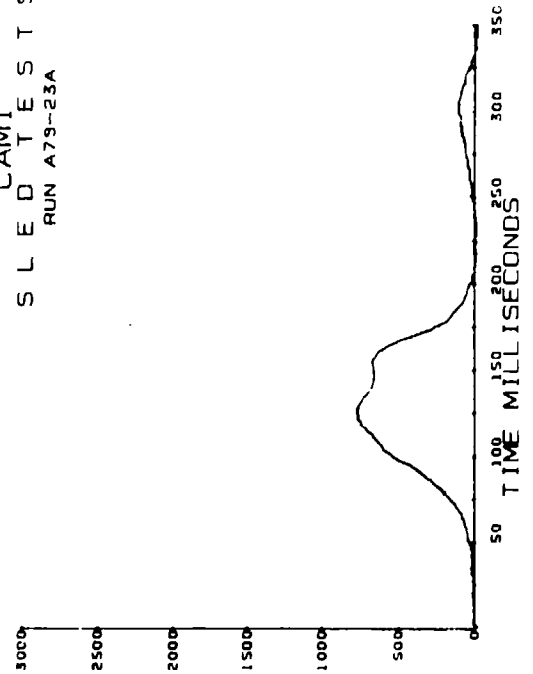


RIGHT LAP FORCE (LB)

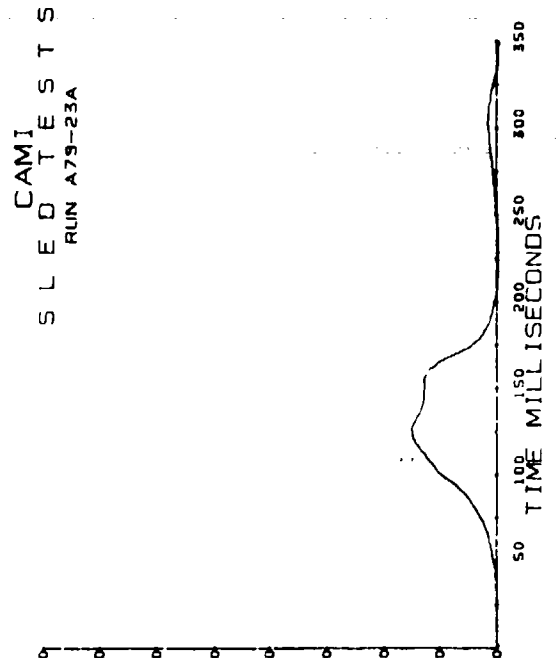


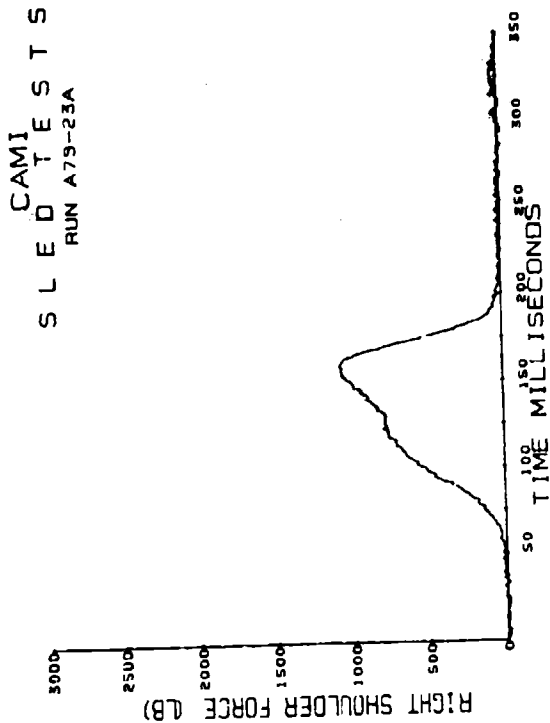
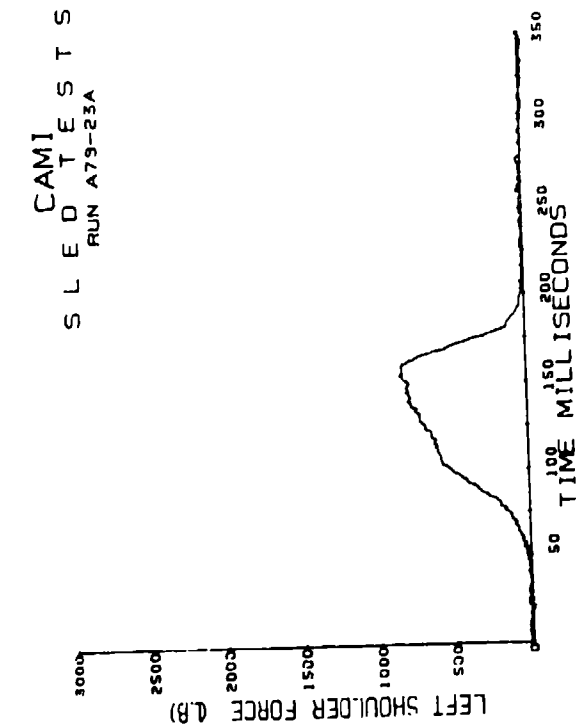
CAMI
S L E D T E S T S
RUN A79-23A

LEFT LAP FORCE (LB)

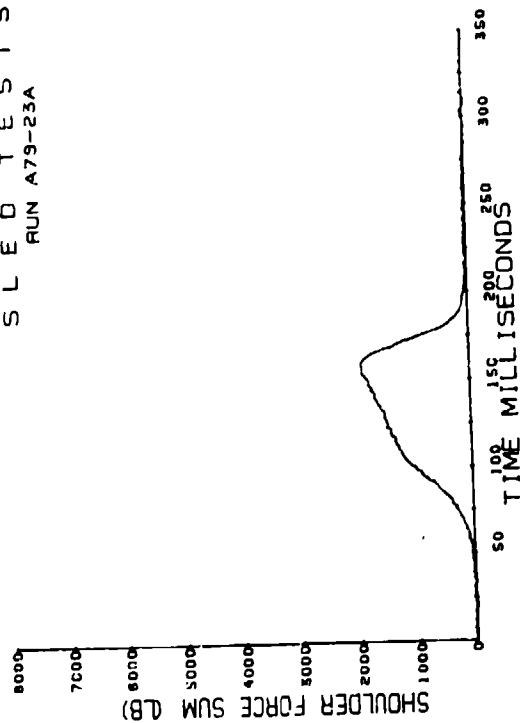


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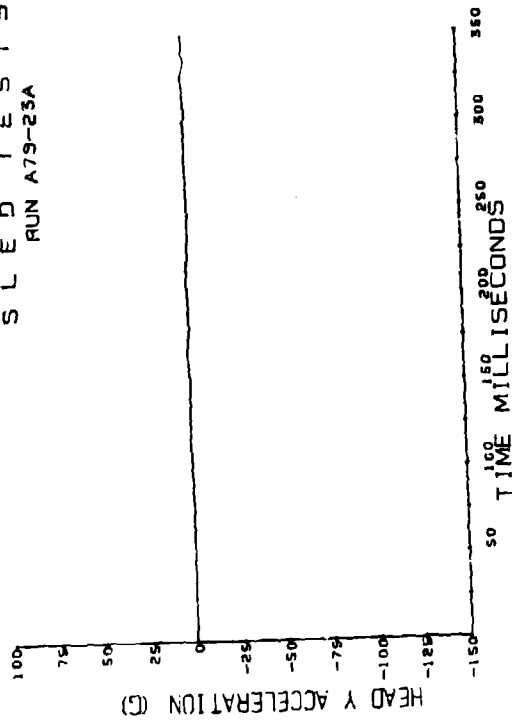




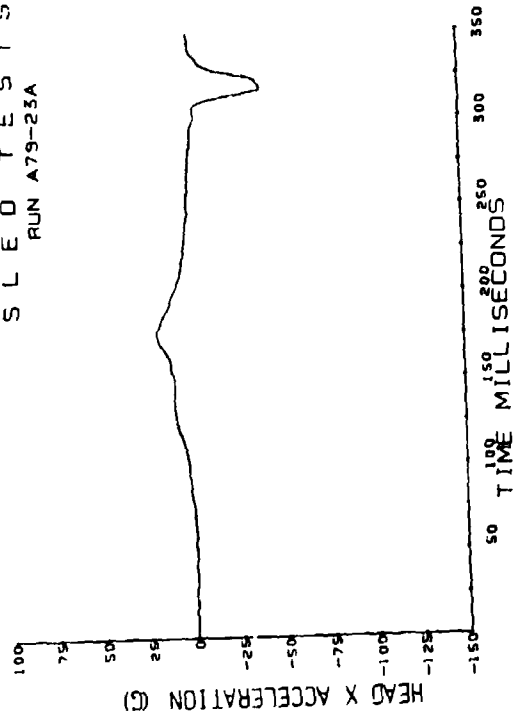
CAMI
S L E D T E S T S
RUN A79-23A



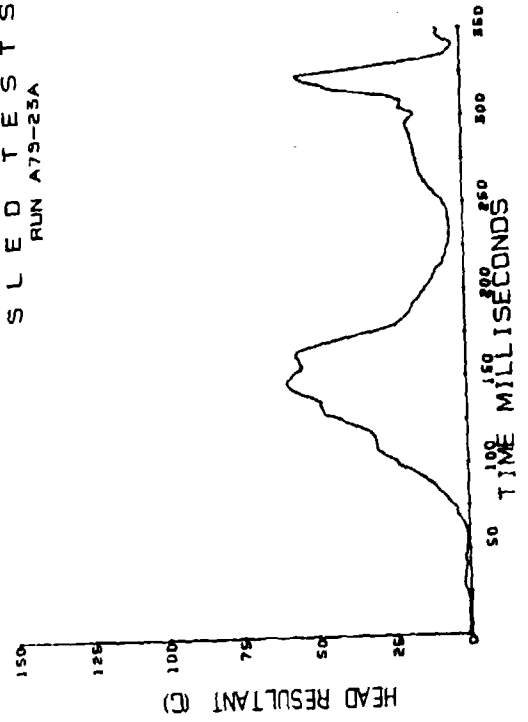
CAMI
S L E D T E S T S
RUN A79-23A



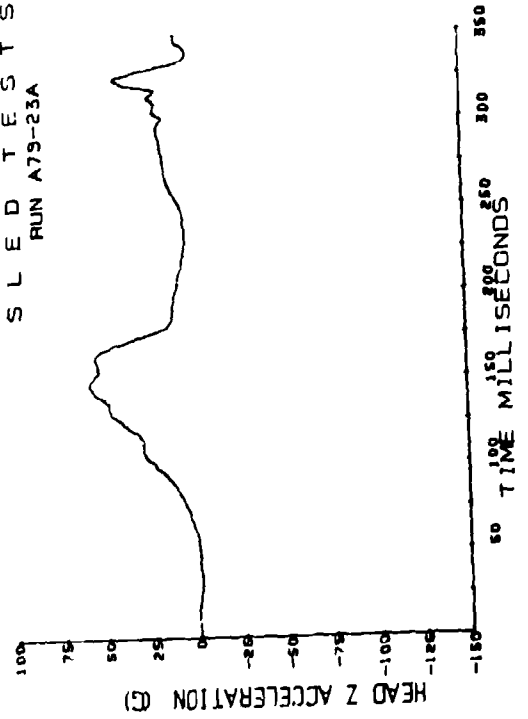
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S L E D T E S T S
RUN A79-23A

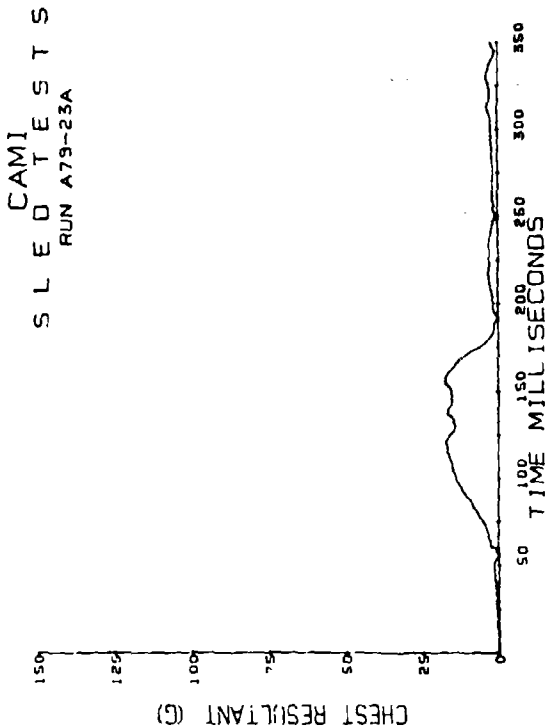
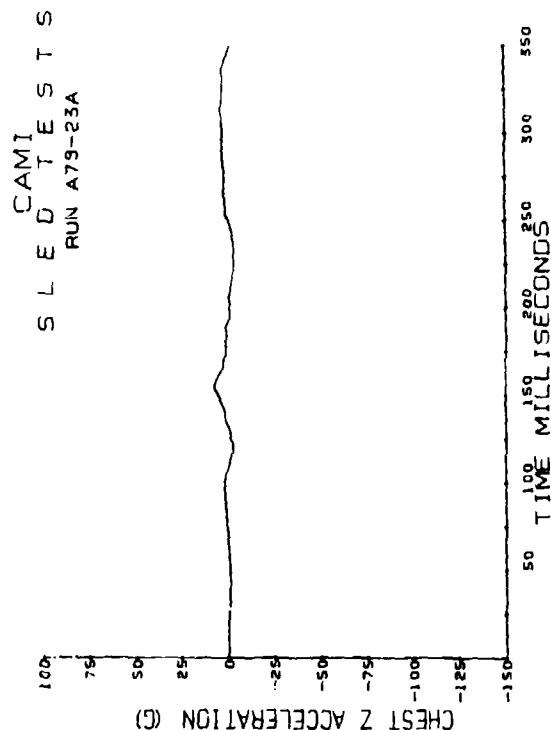
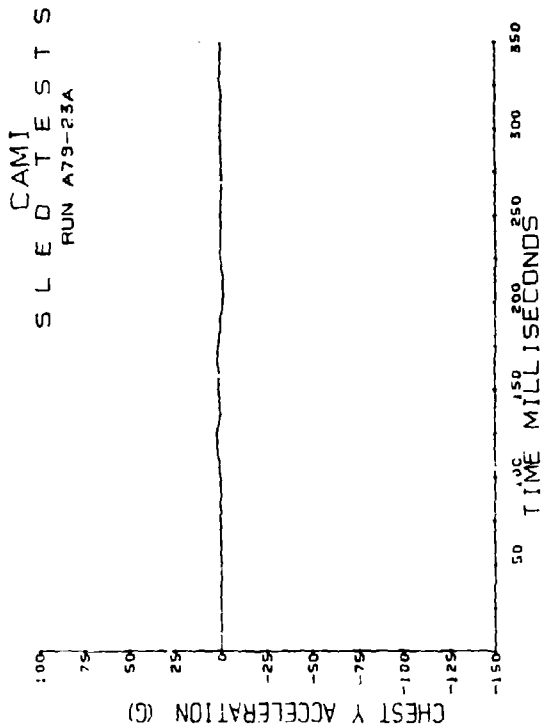
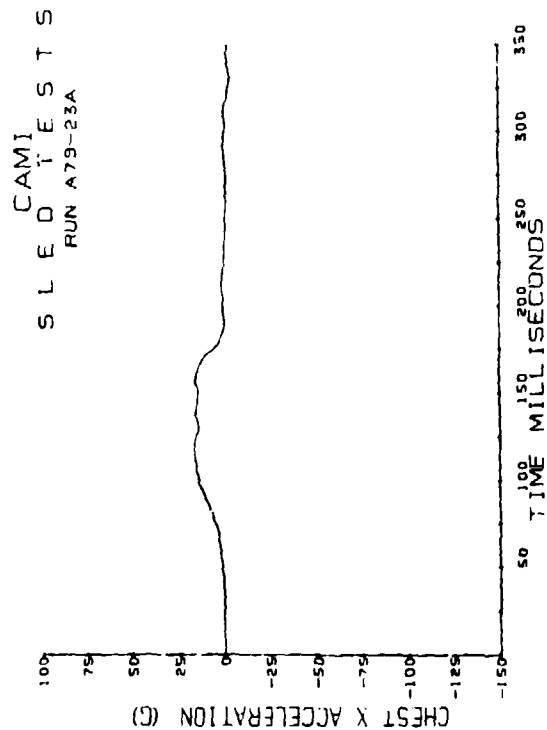


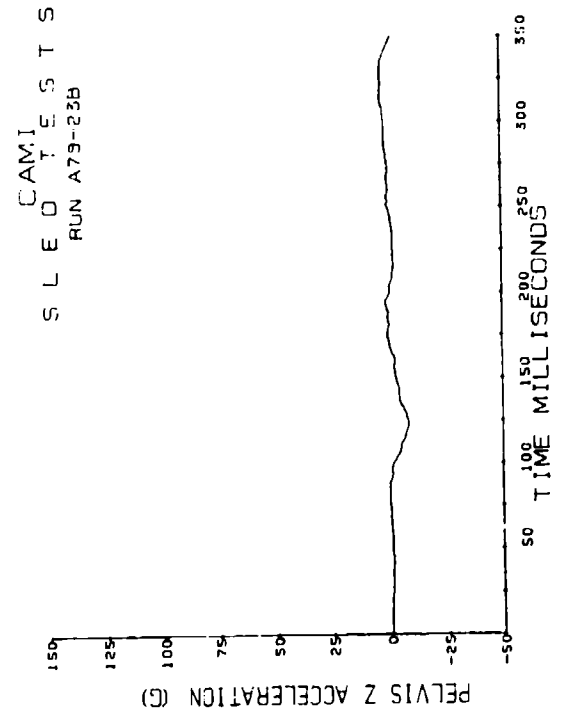
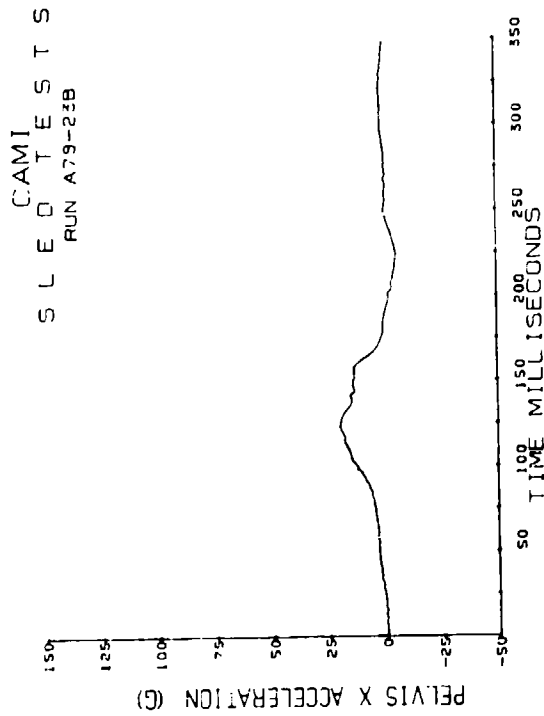
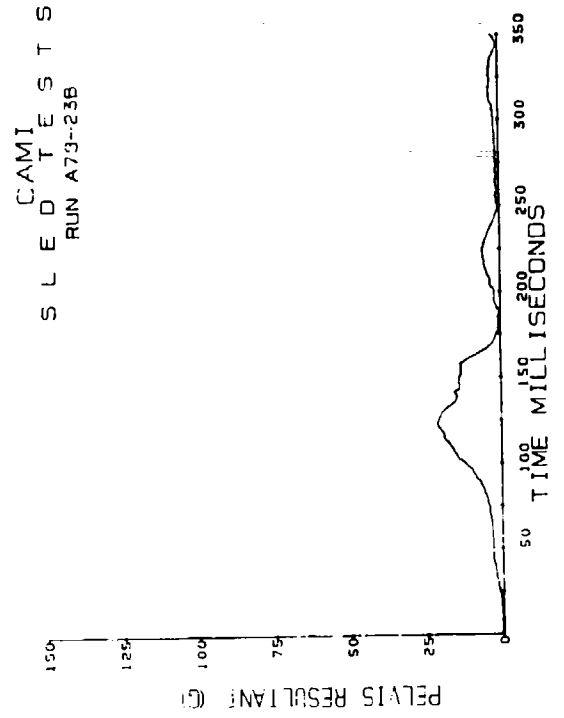
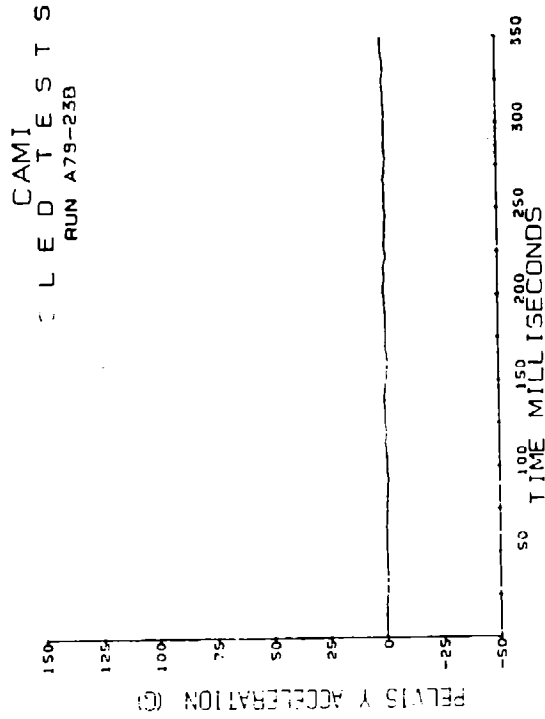
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S L E D T E S T S
RUN A79-23A

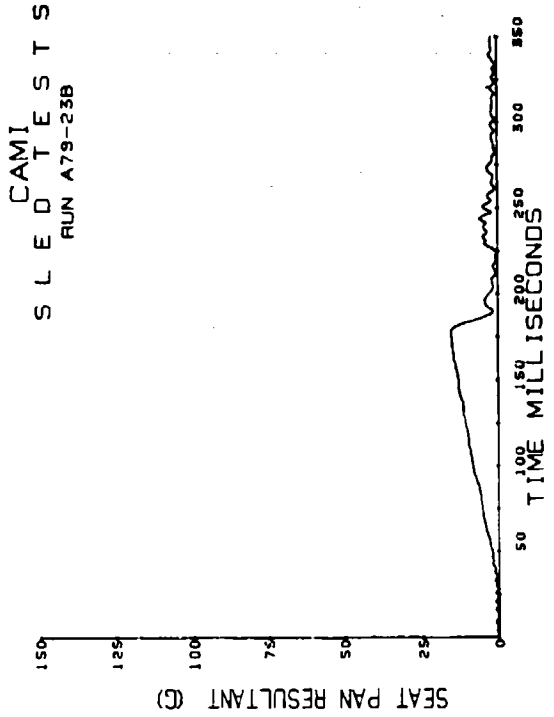
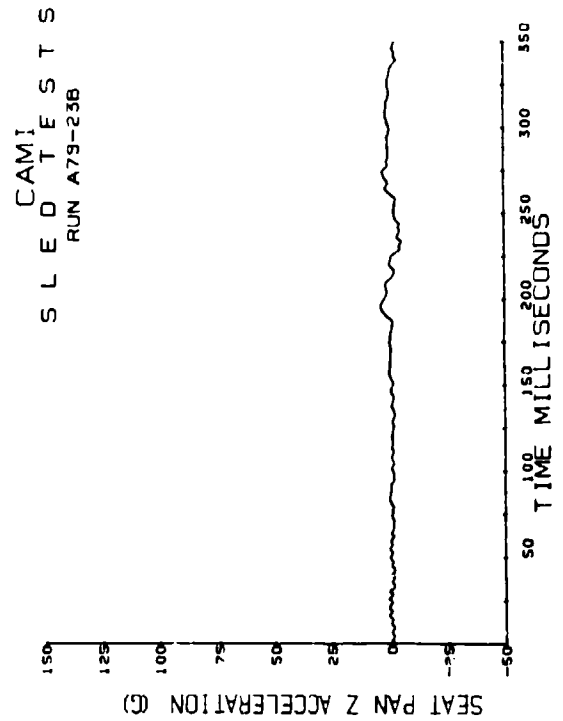
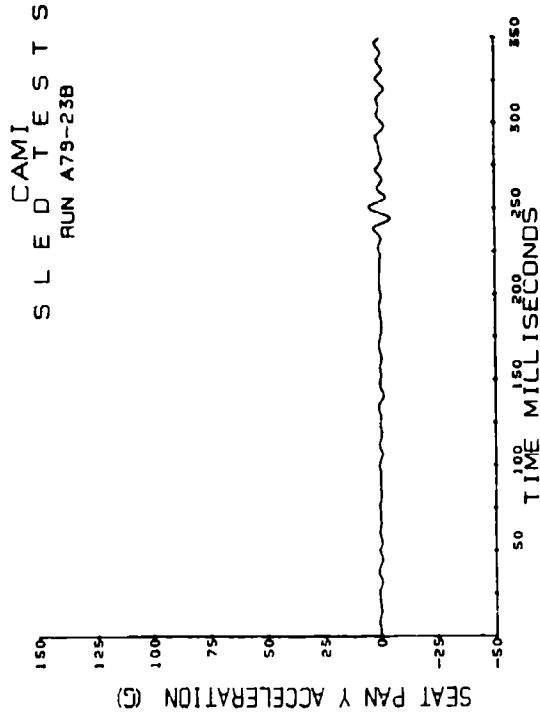
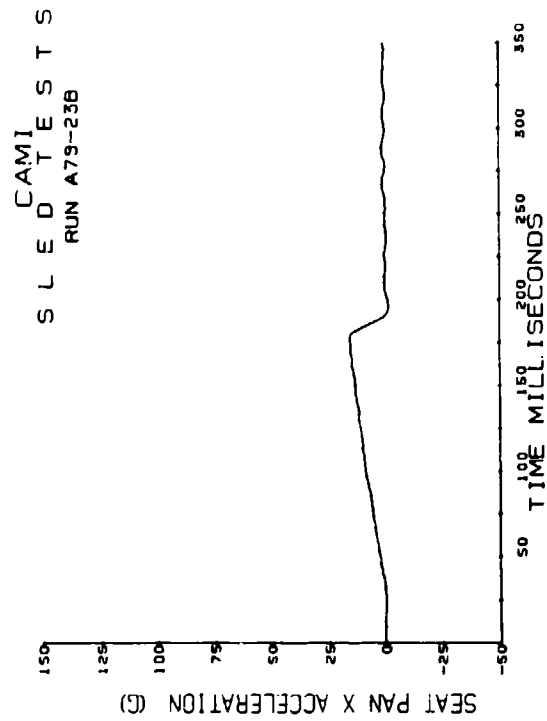


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S L E D T E S T S
RUN A79-23A

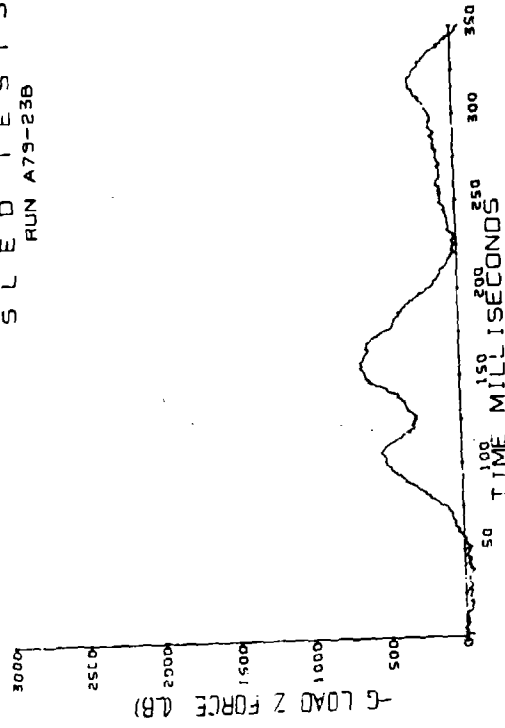




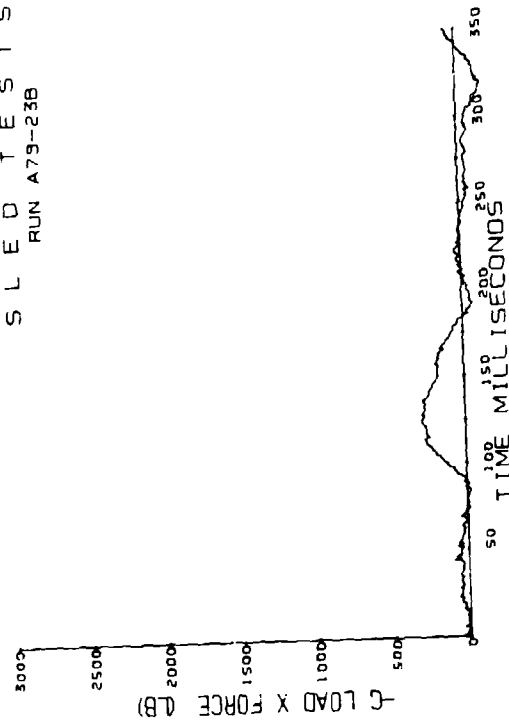




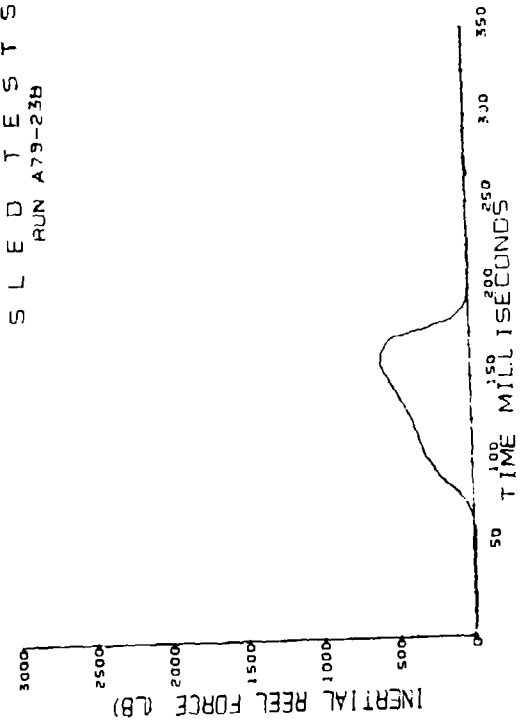
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S L E D T E S T S
RUN A79-23B

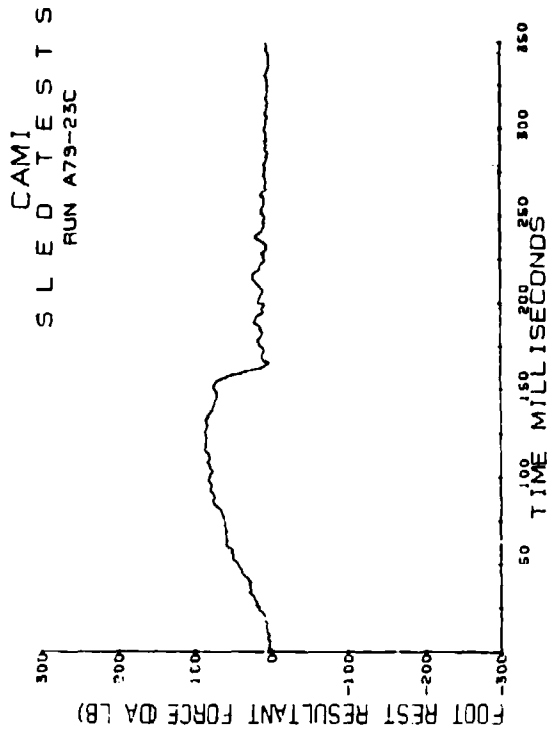
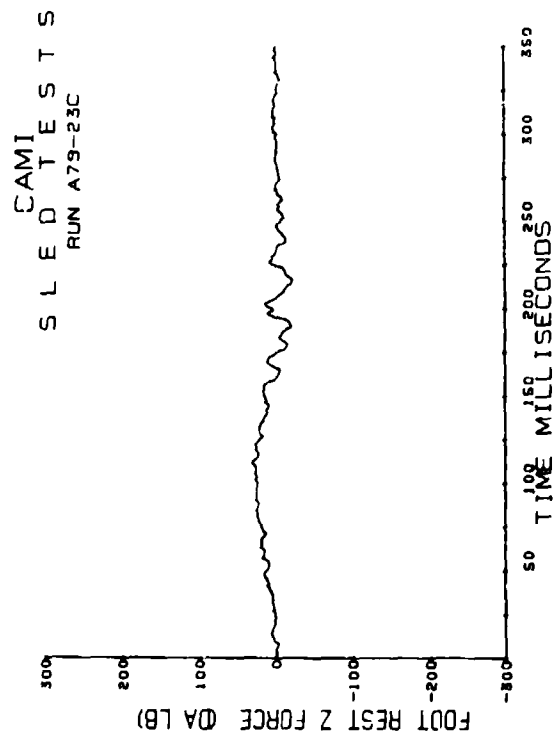
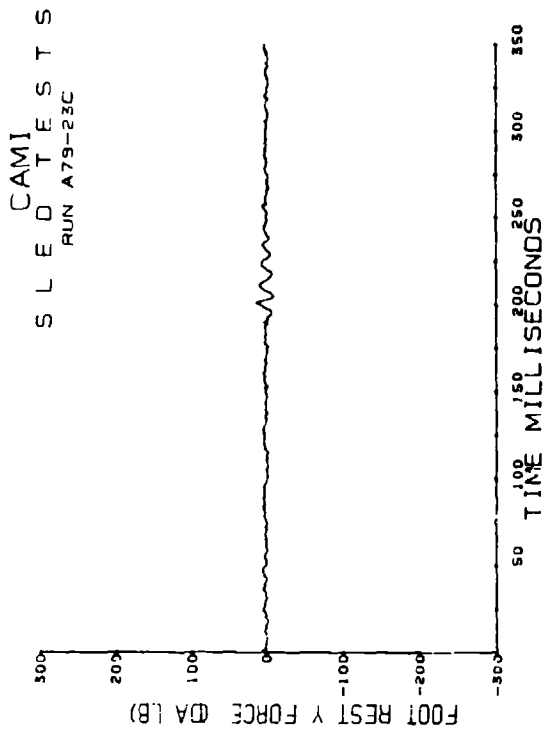
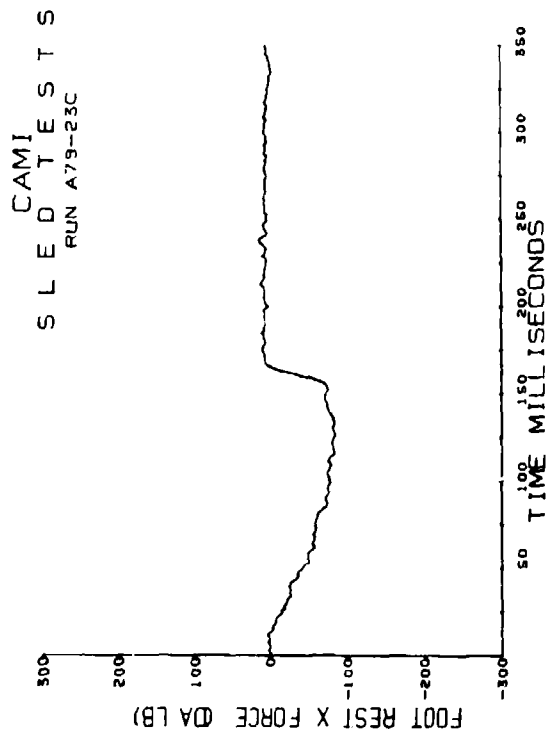


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S L E D T E S T S
RUN A79-23B

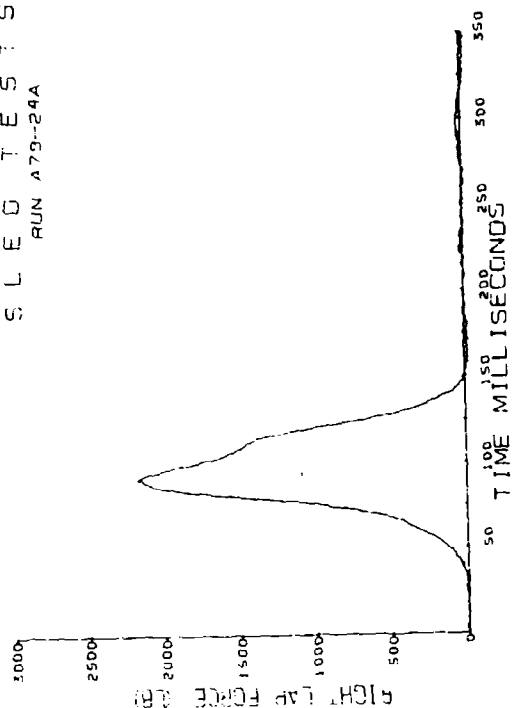


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S L E D T E S T S
RUN A79-23B

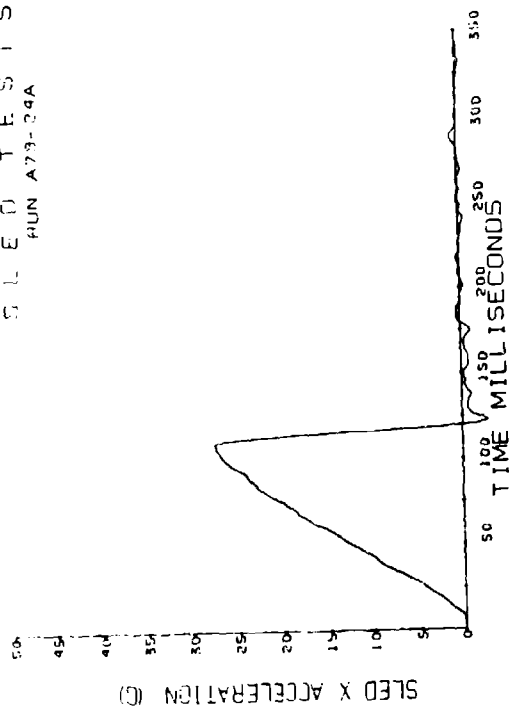




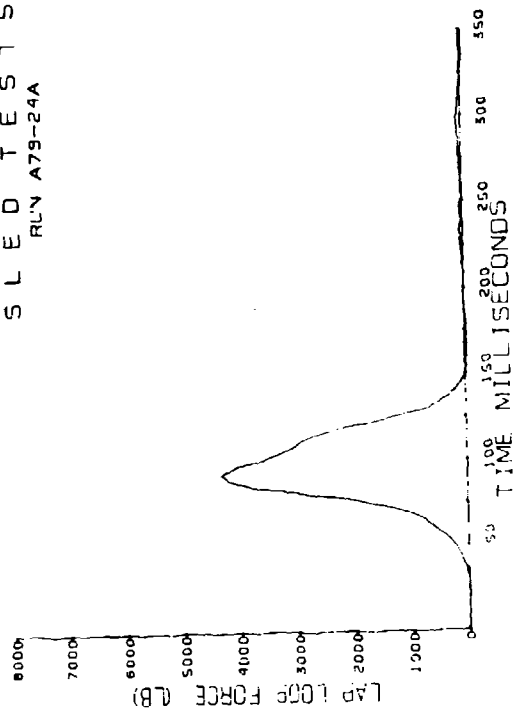
CAMI
SLED TESTS
RUN A79-24A



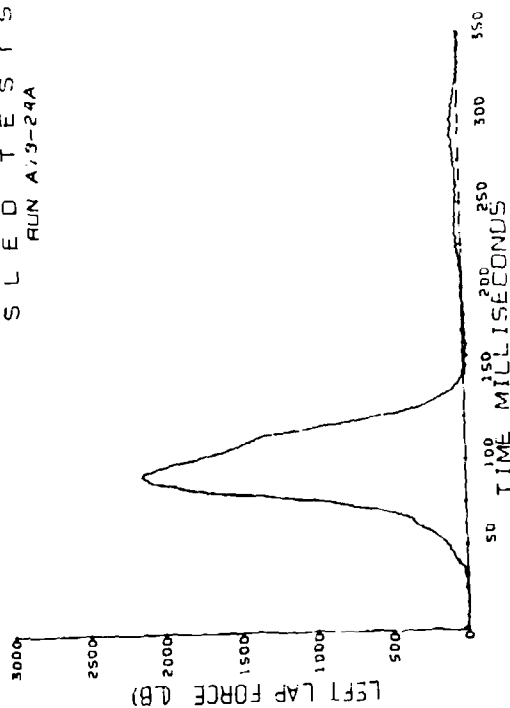
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SLED TESTS
RUN A79-24A



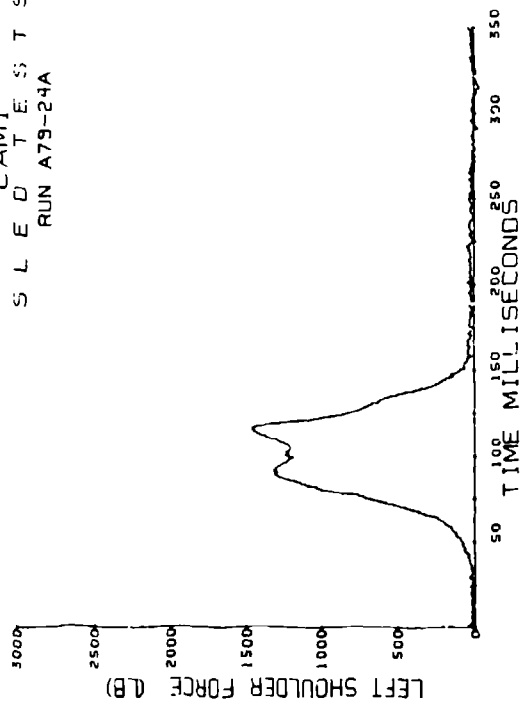
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SLED TESTS
RUN A79-24A



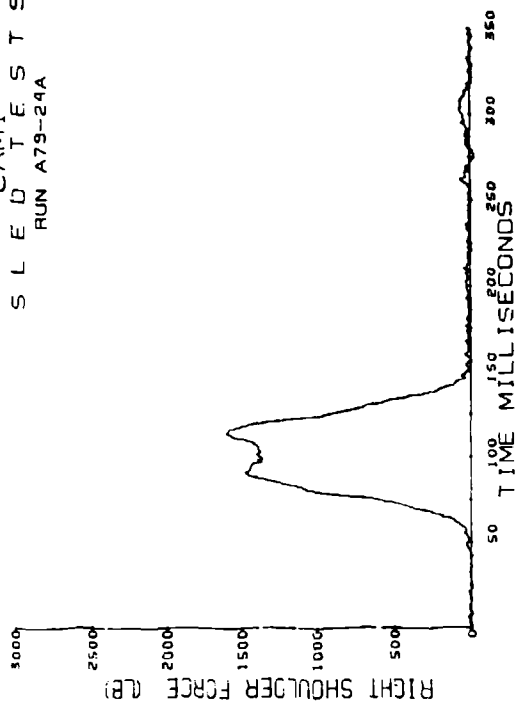
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SLED TESTS
RUN A79-24A



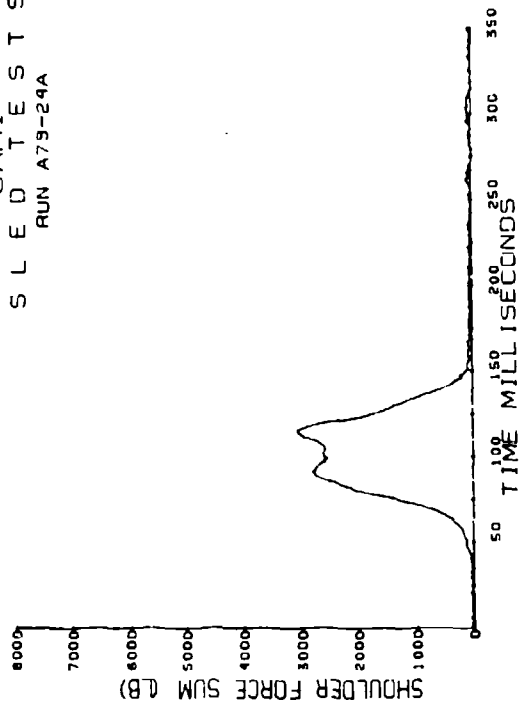
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S L E D T E S T S
RUN A79-24A

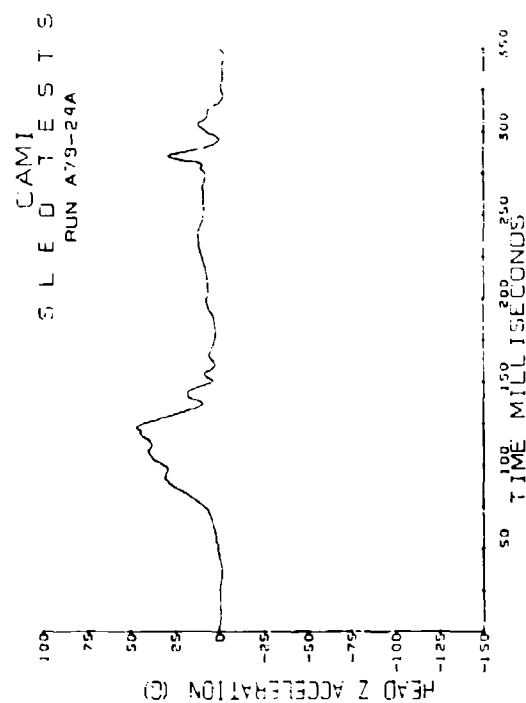
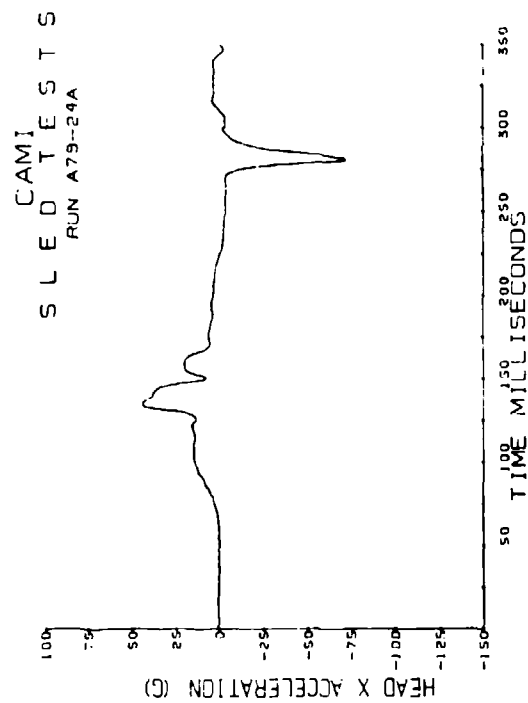
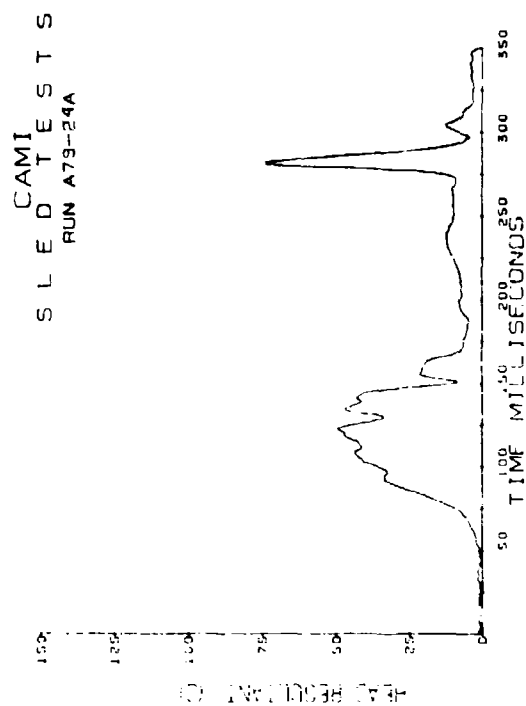
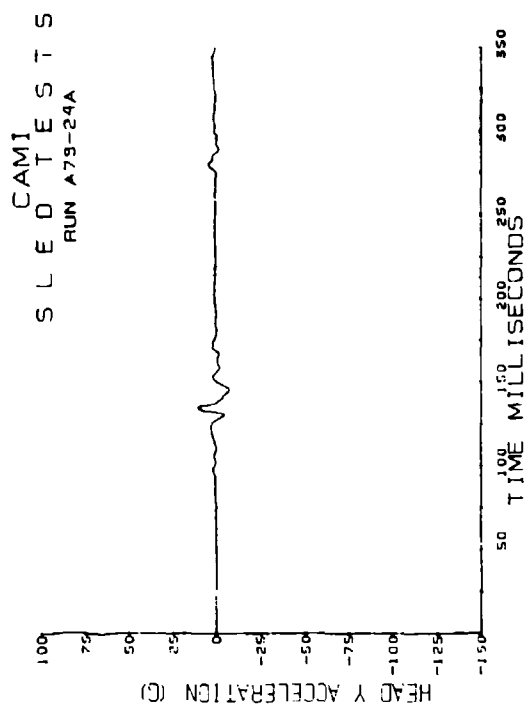


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S L E D T E S T S
RUN A79-24A

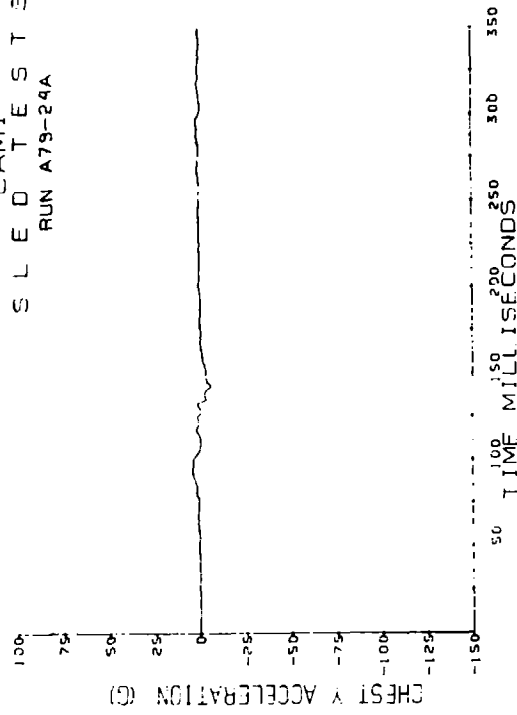


CAMI
S L E D T E S T S
RUN A79-24A

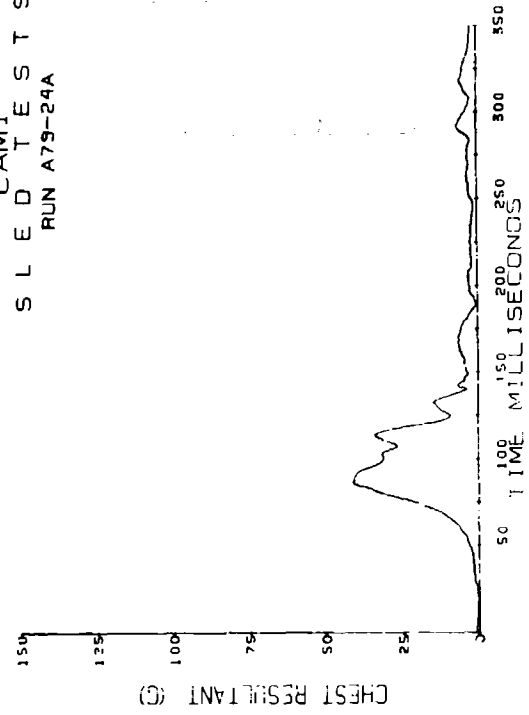




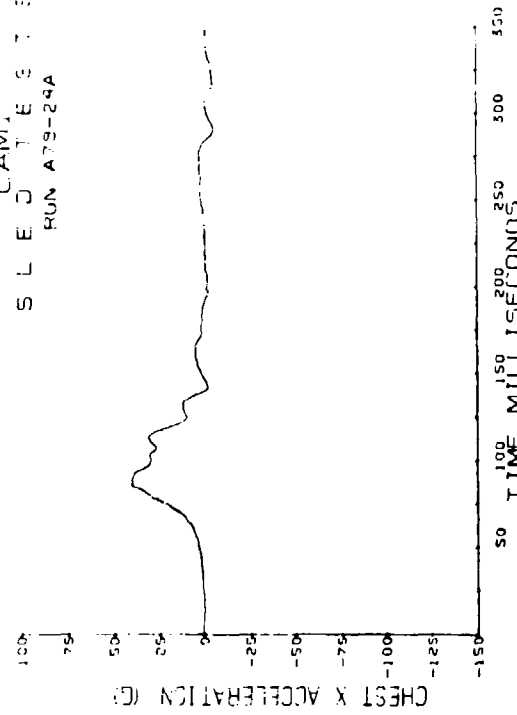
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S L E D T E S T S
RUN A79-24A



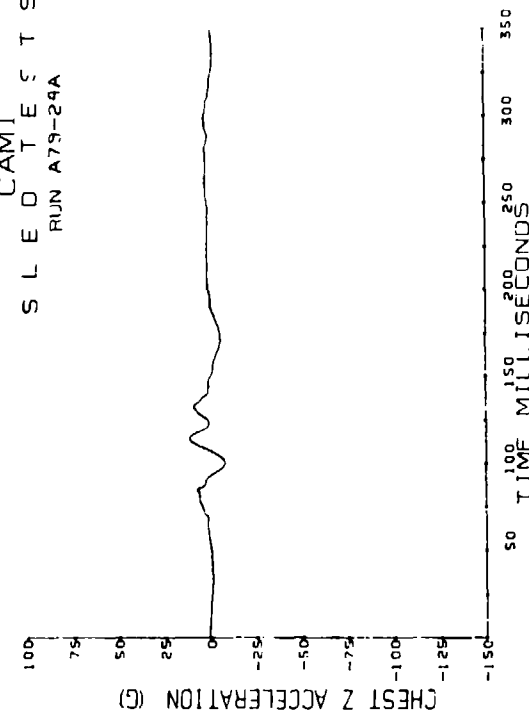
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S L E D T E S T S
RUN A79-24A

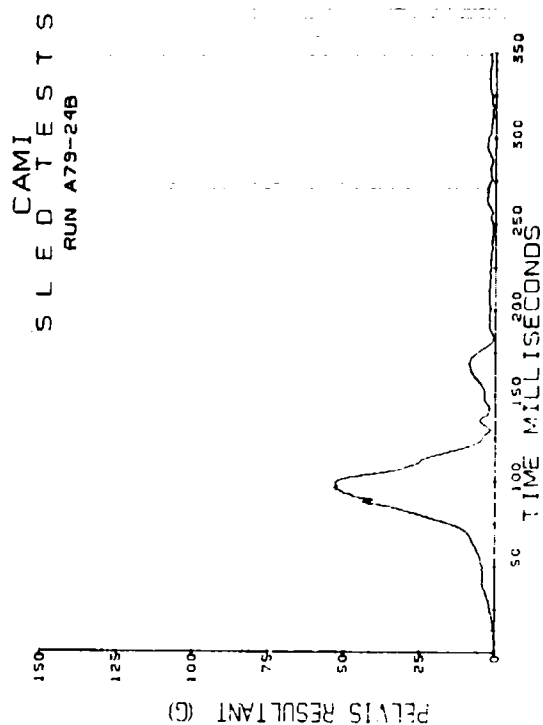
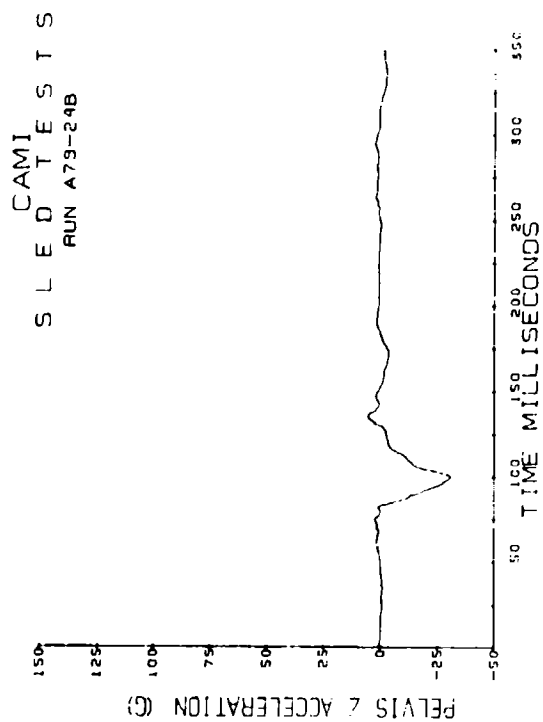
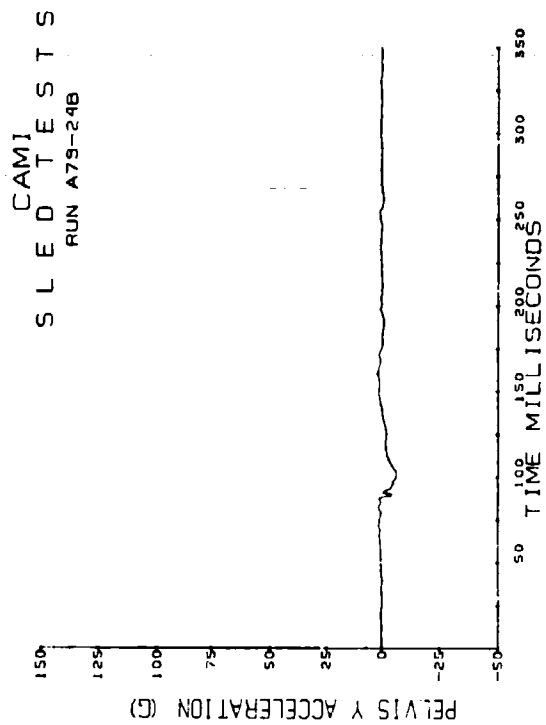
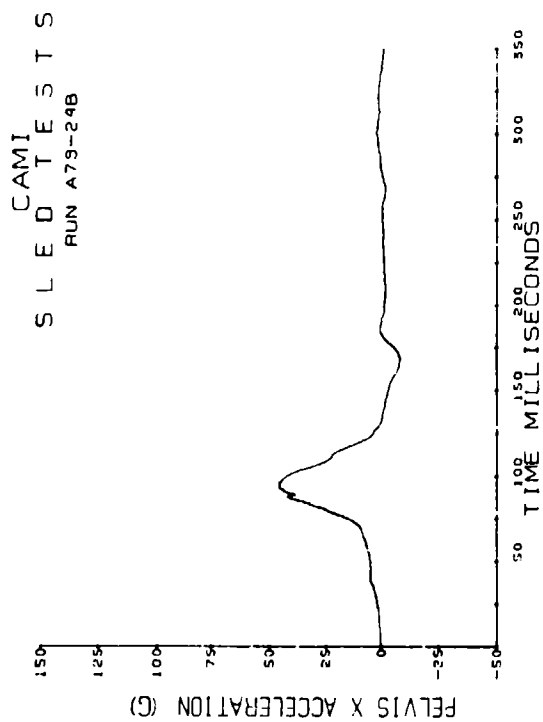


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S L E D T E S T S
RUN A79-24A

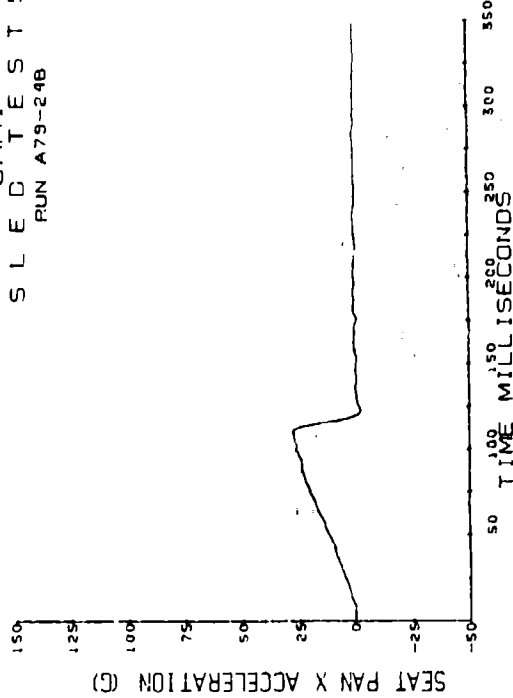


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S L E D T E S T S
RUN A79-24A

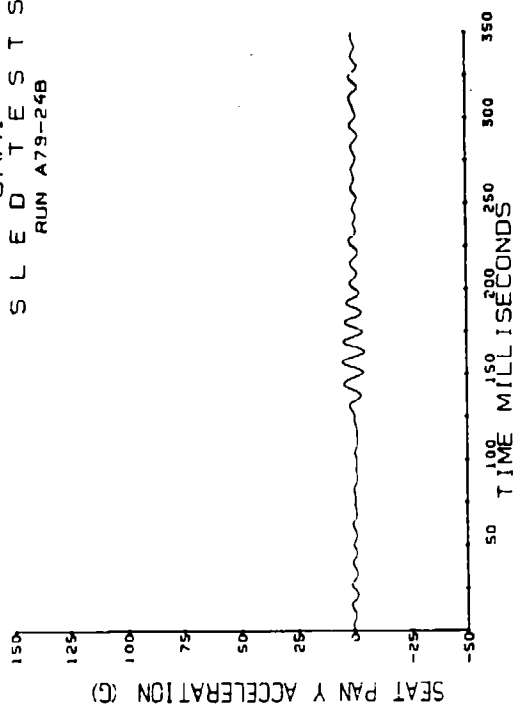




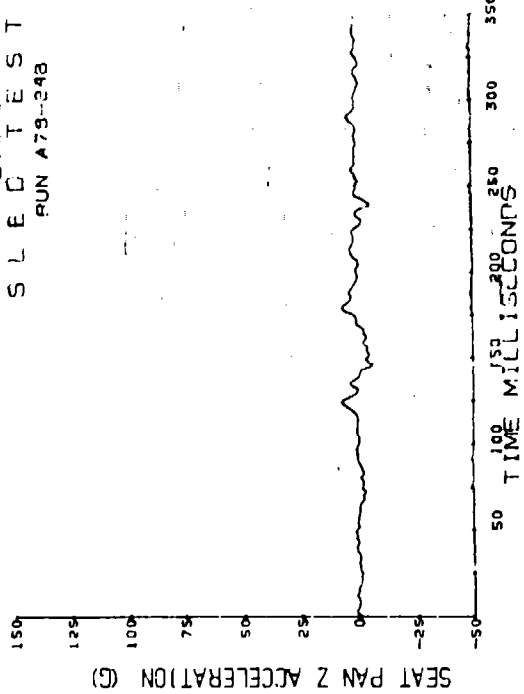
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S L E D T E S T S
RUN A79-24B



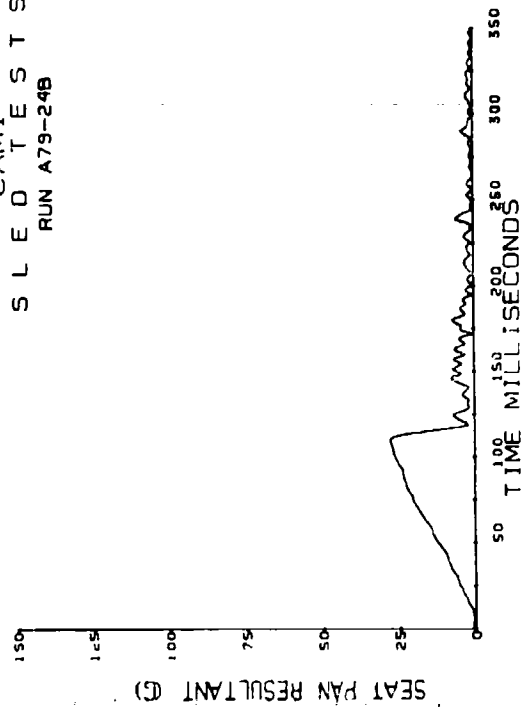
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S L E D T E S T S
RUN A79-24B



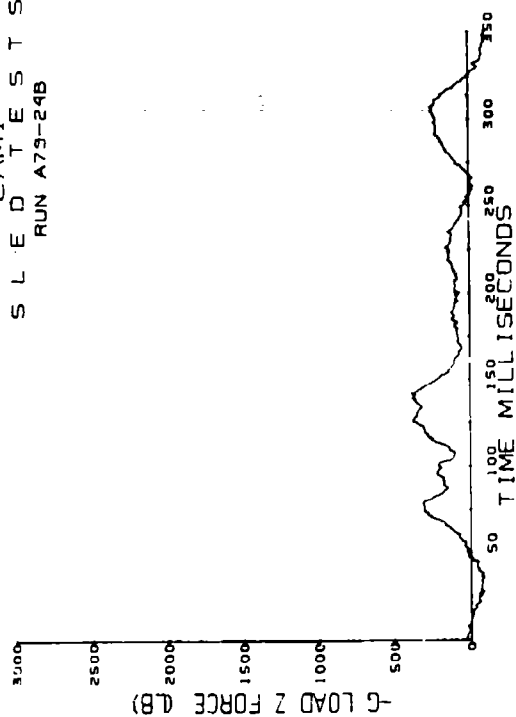
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S L E D T E S T S
RUN A79-24B



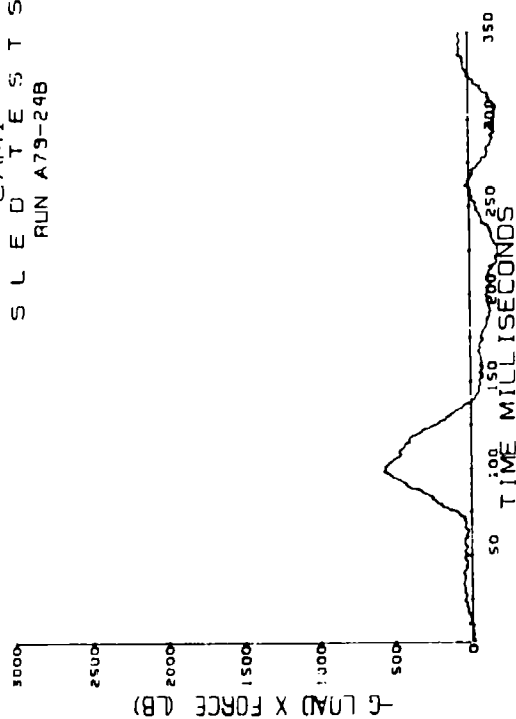
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S L E D T E S T S
RUN A79-24B



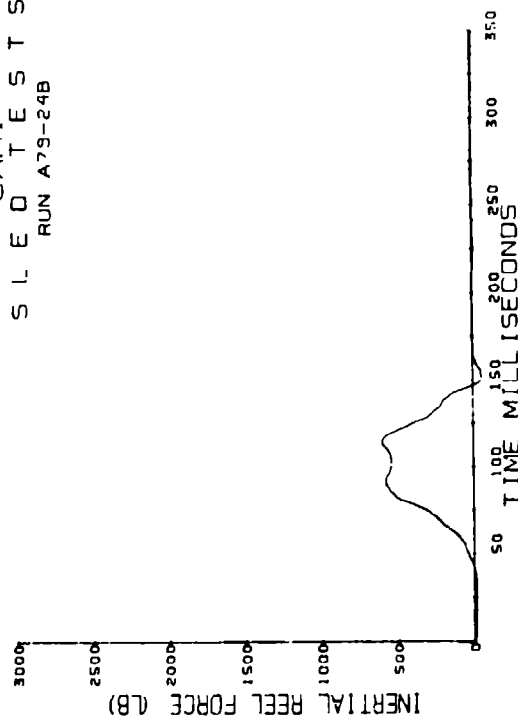
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S L E D T E S T S
RUN A79-24B

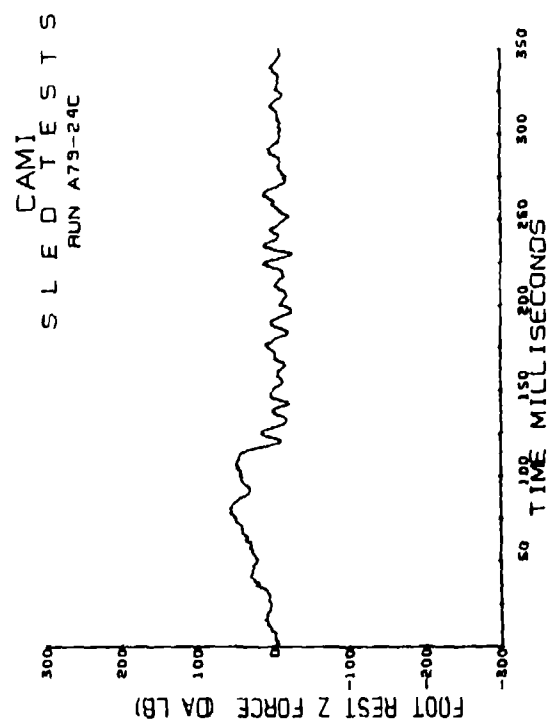
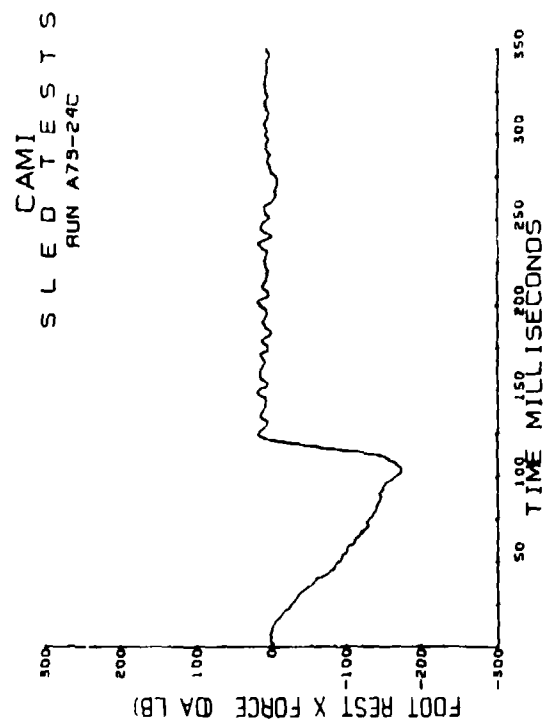
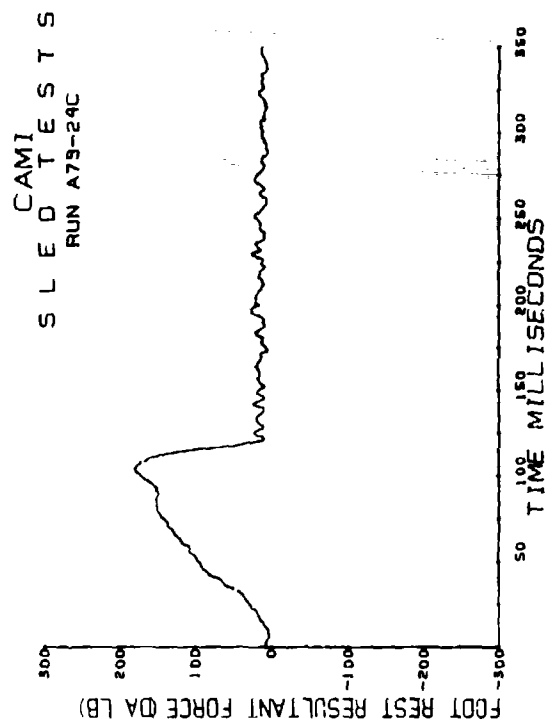
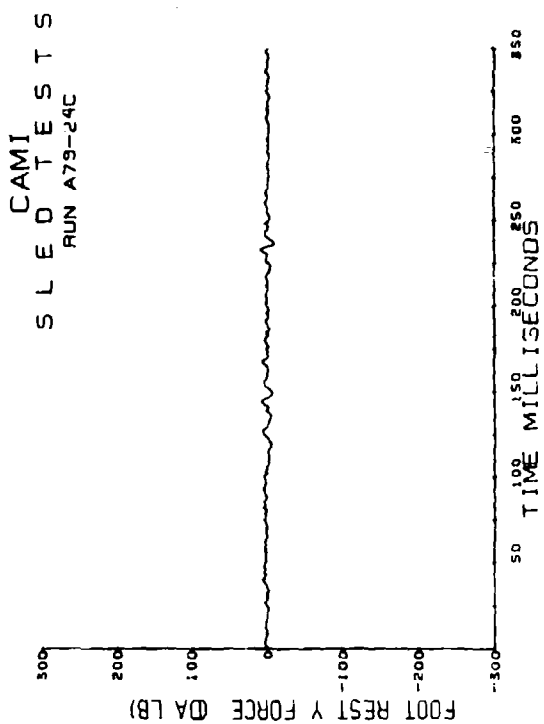


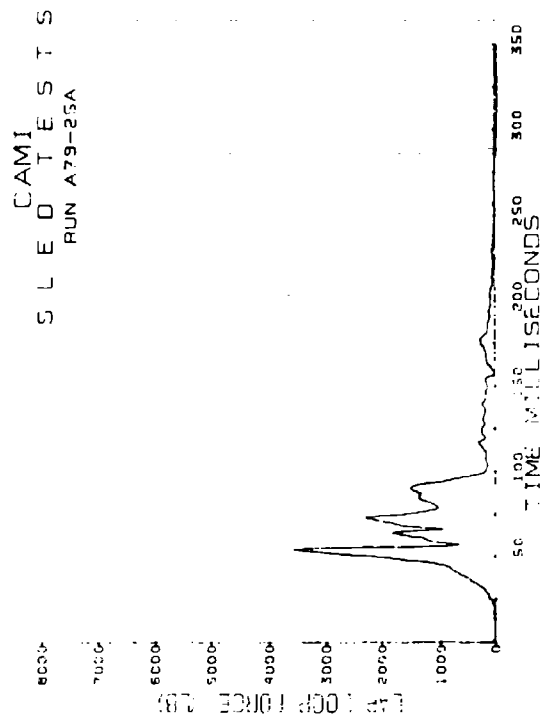
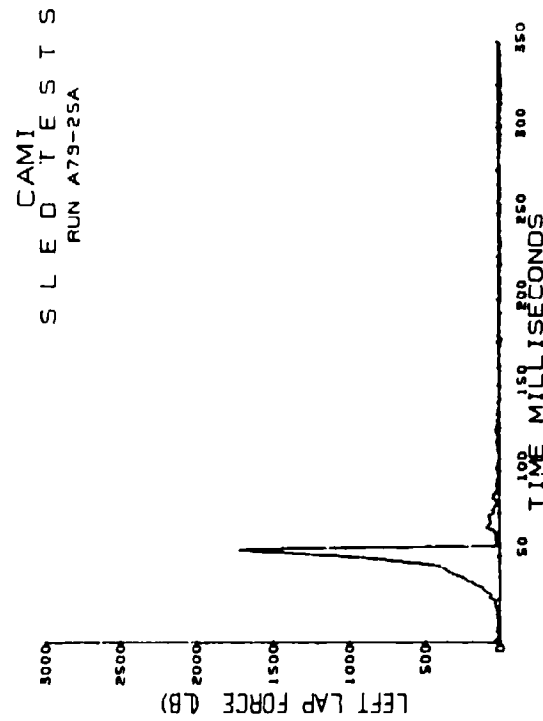
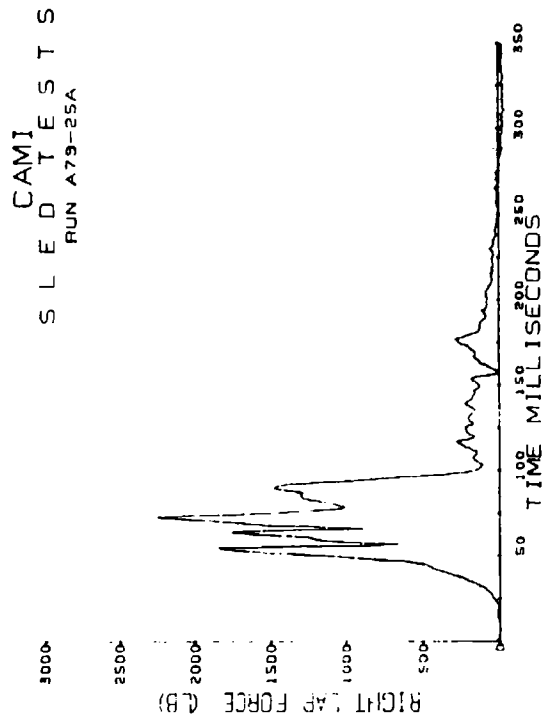
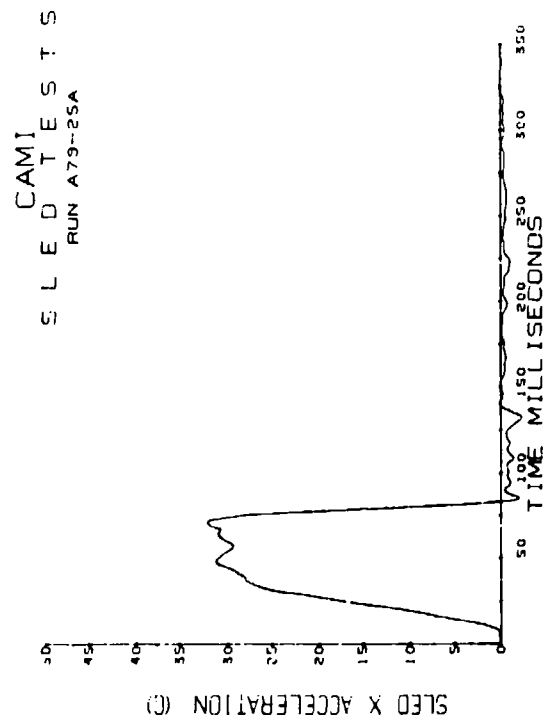
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S L E D T E S T S
RUN A79-24B



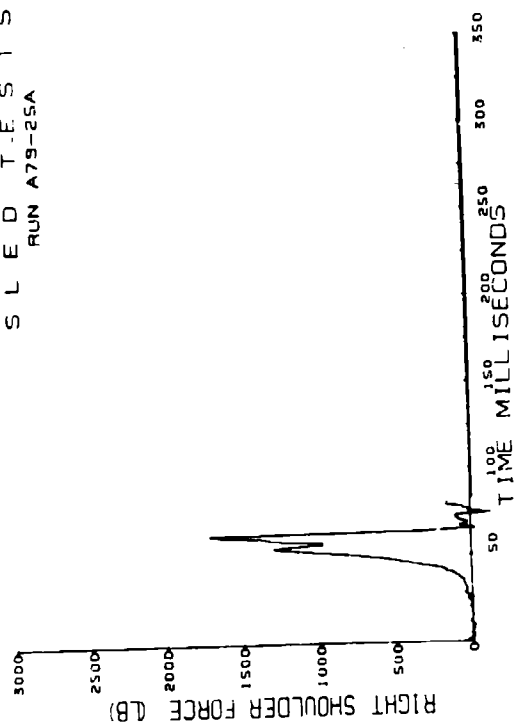
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S L E D T E S T S
RUN A79-24B



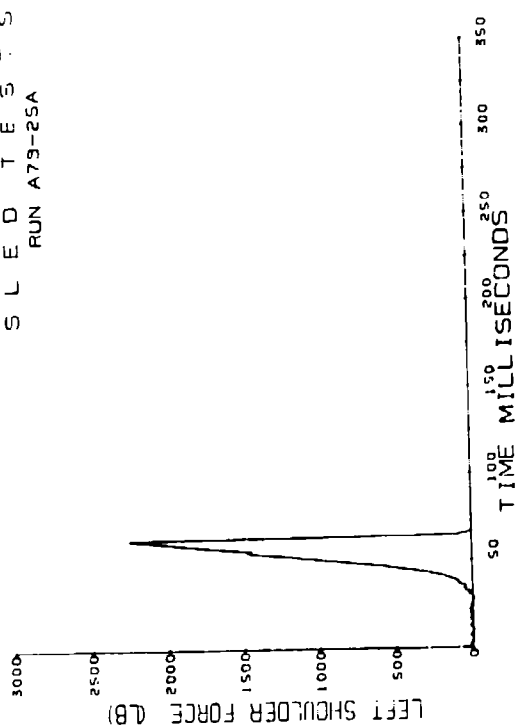




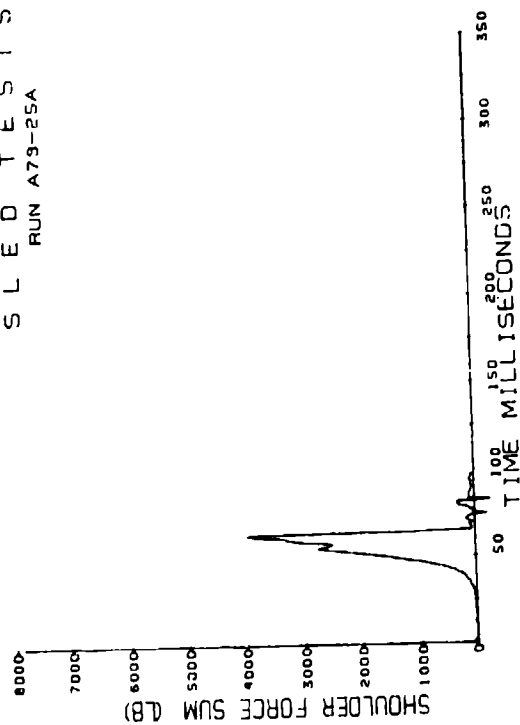
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S L E D T E S T S
RUN A79-25A

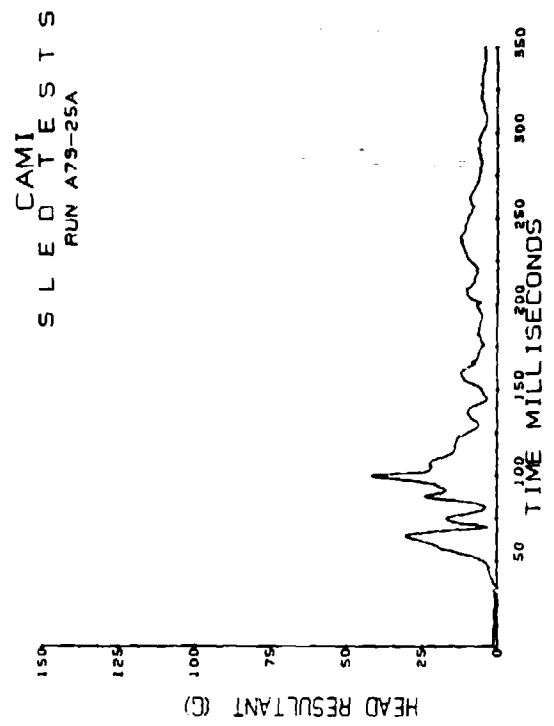
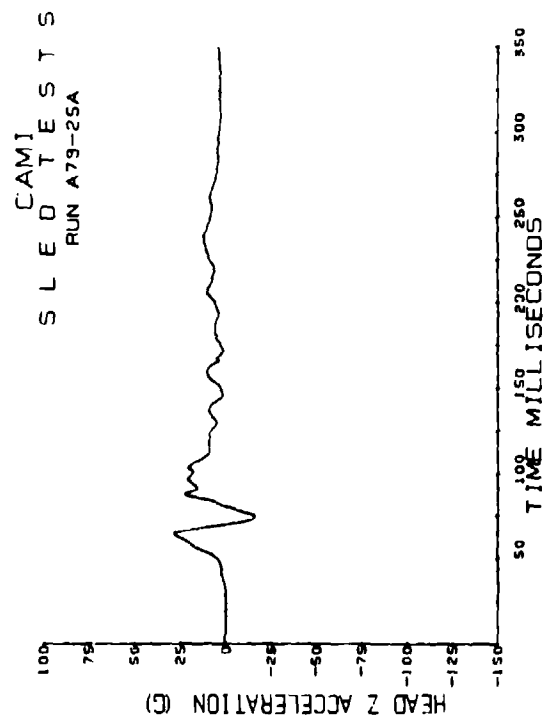
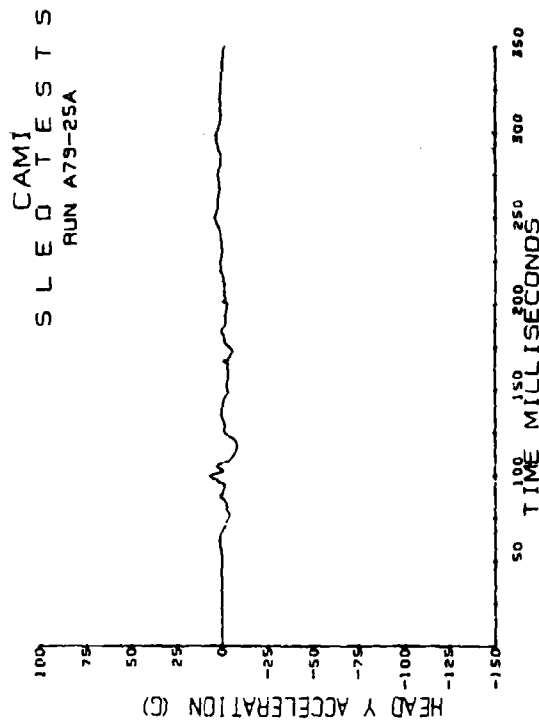
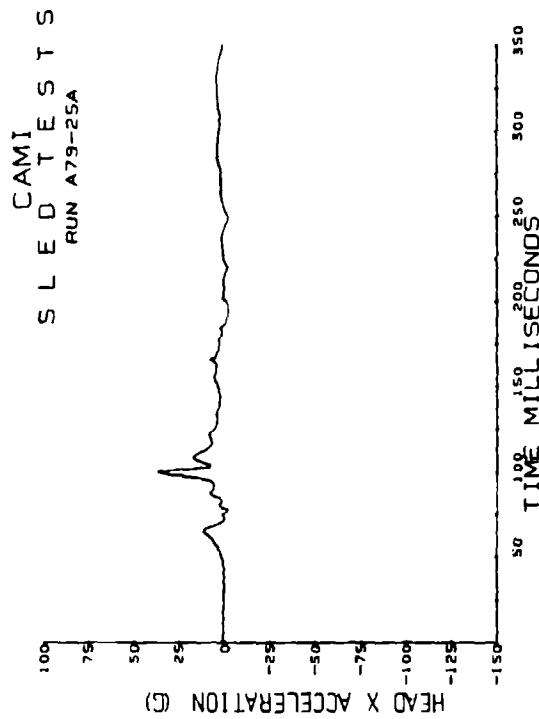


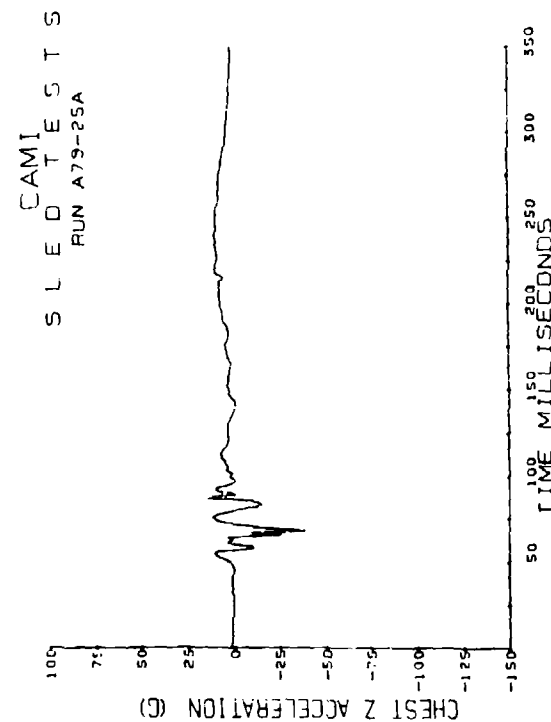
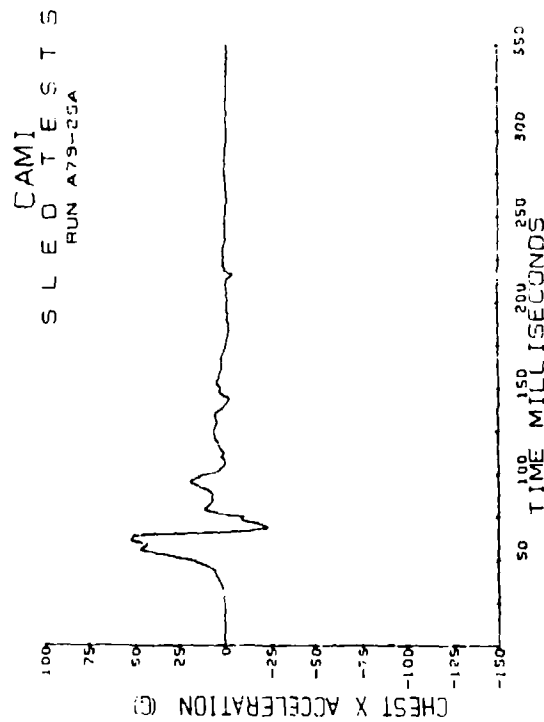
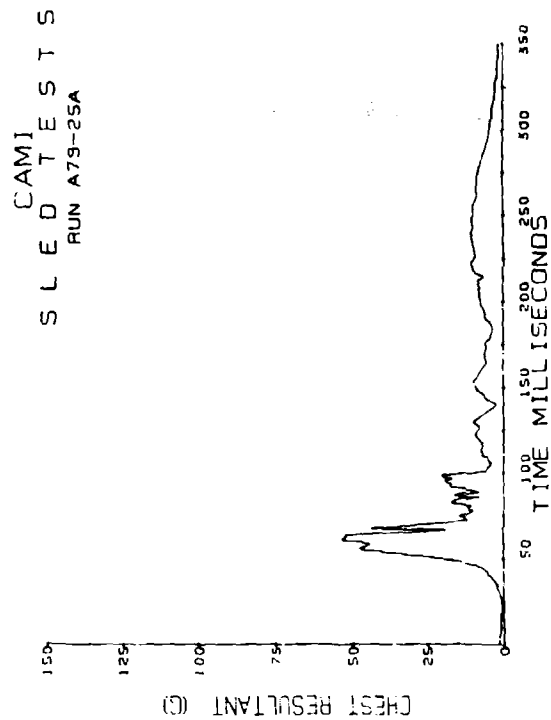
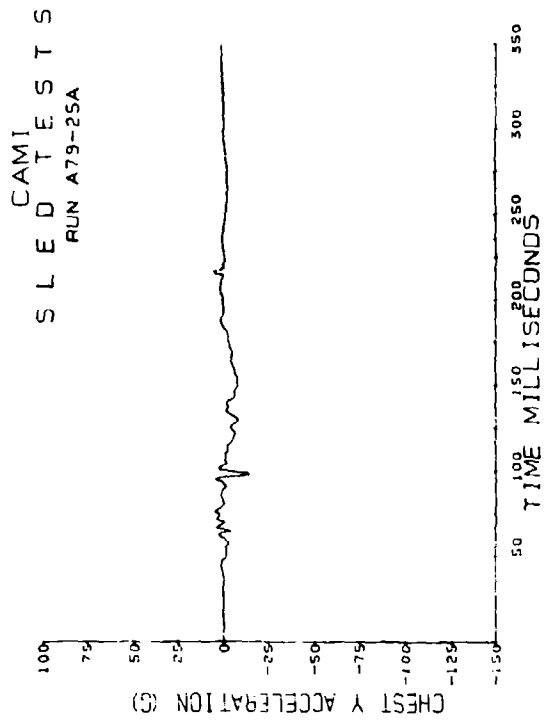
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S L E D T E S T S
RUN A79-25A



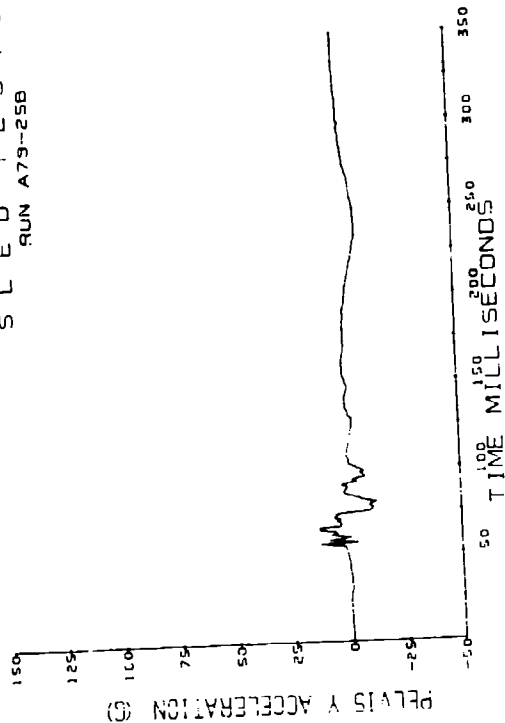
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S L E D T E S T S
RUN A79-25A



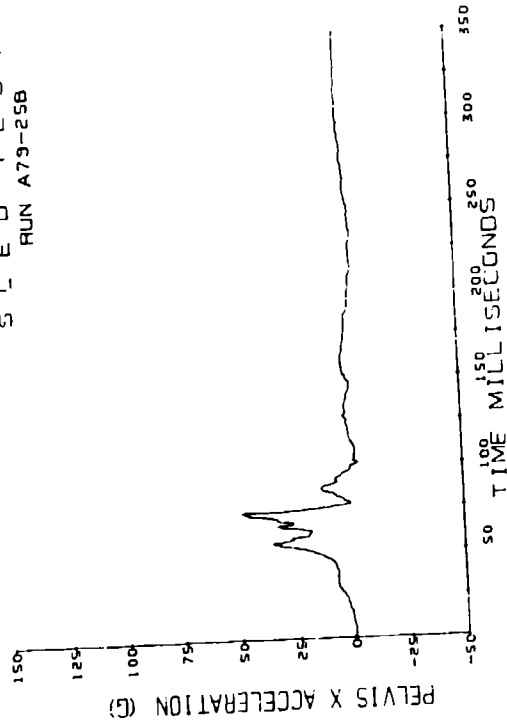




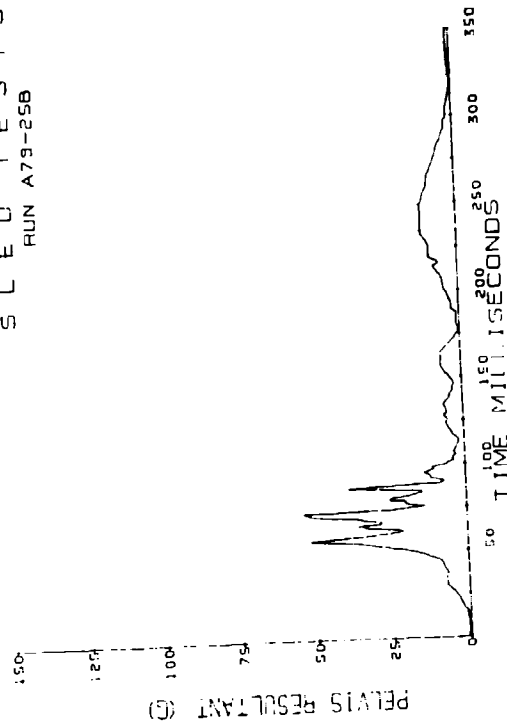
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S L E D T E S T S
RUN A79-25B



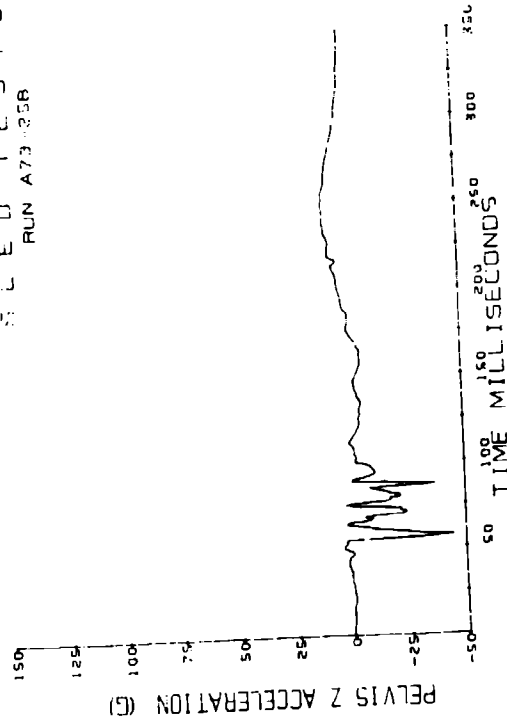
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S L E D T E S T S
RUN A79-25B



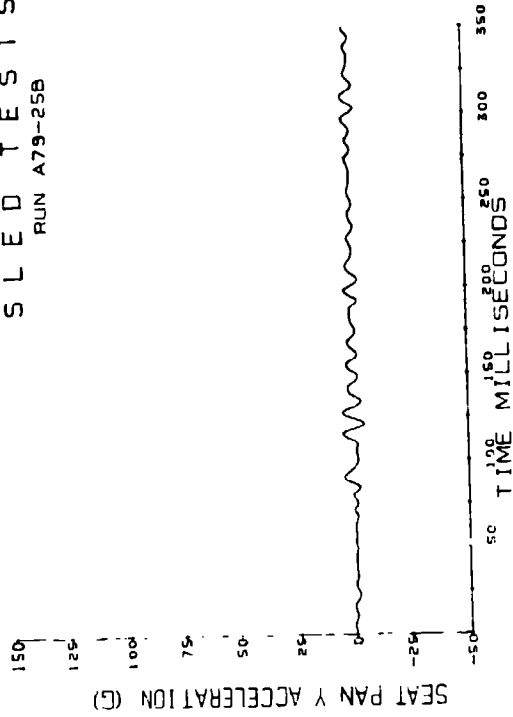
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S L E D T E S T S
RUN A79-25B



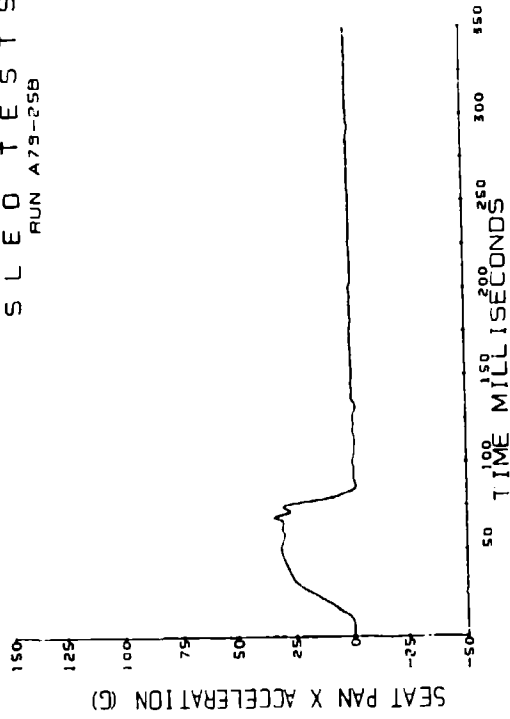
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S L E D T E S T S
RUN A79-25B



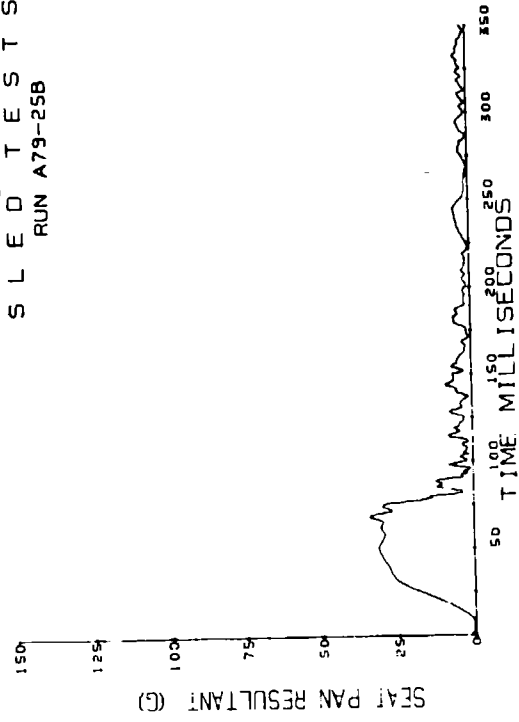
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S L E D T E S T S
RUN A79-25B



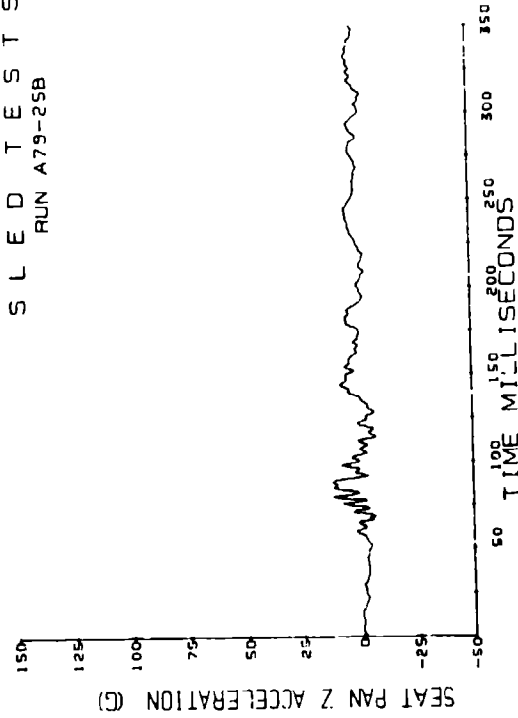
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S L E D T E S T S
RUN A79-25B



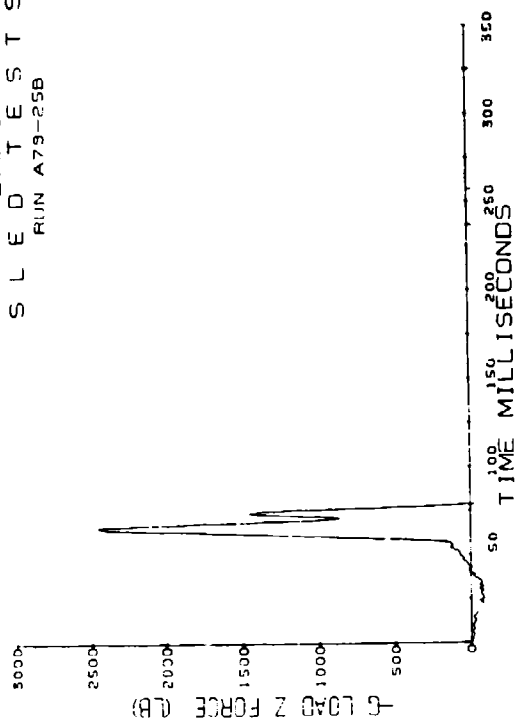
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S L E D T E S T S
RUN A79-25B



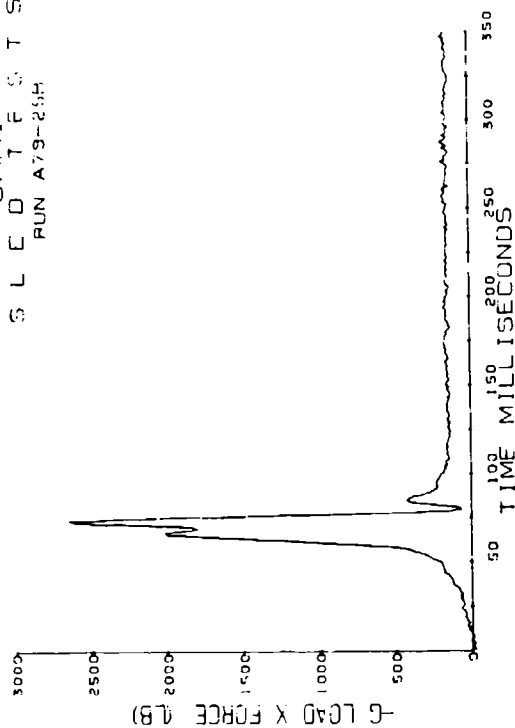
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S L E D T E S T S
RUN A79-25B



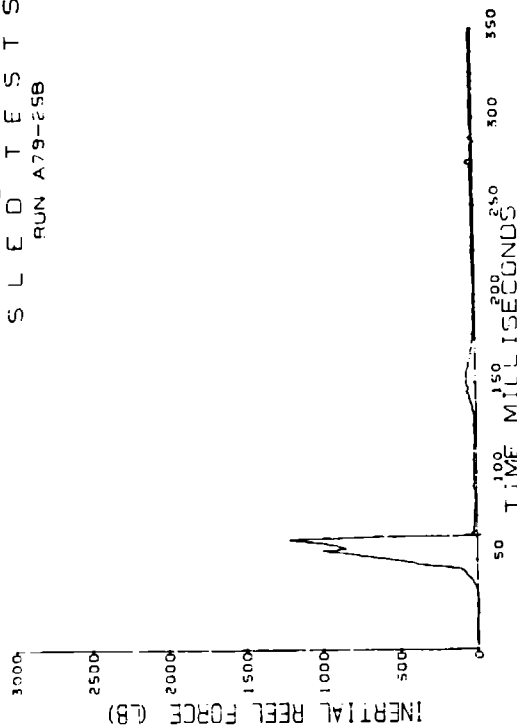
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S L E D T E S T S
RUN A79-25B

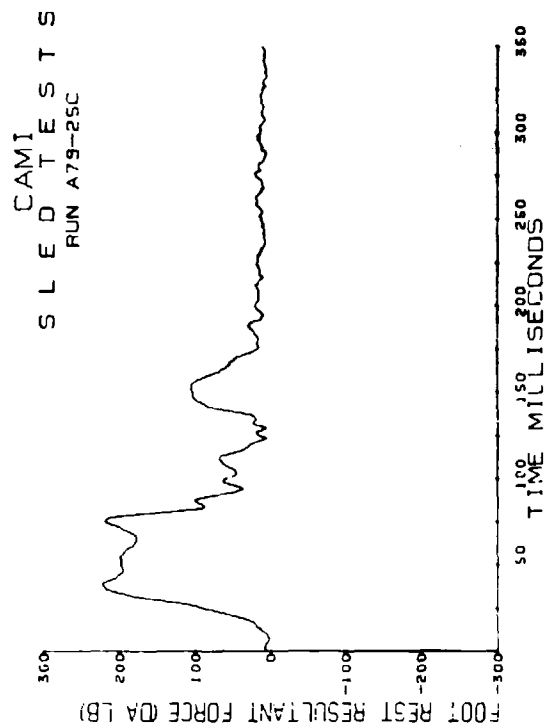
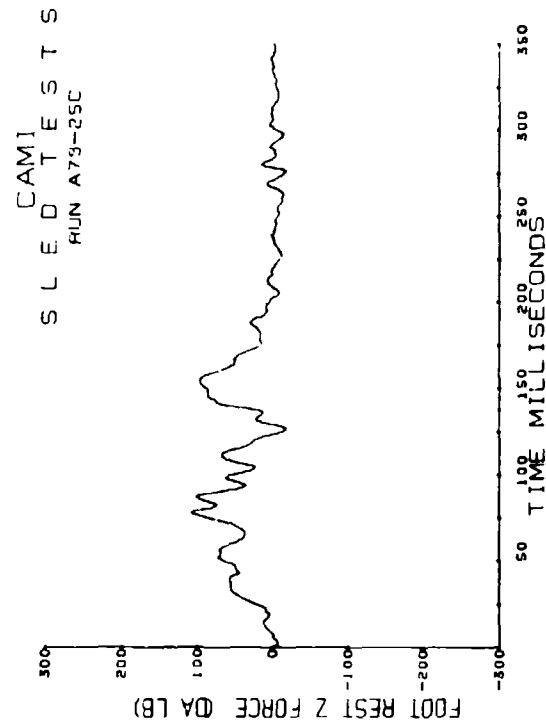
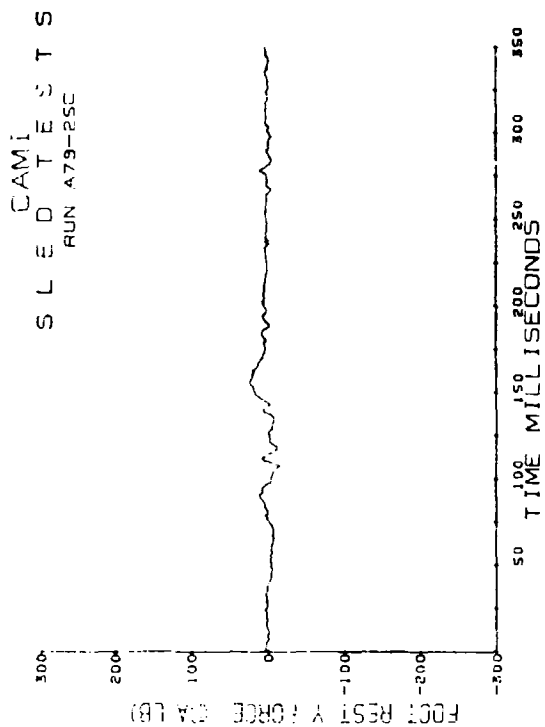
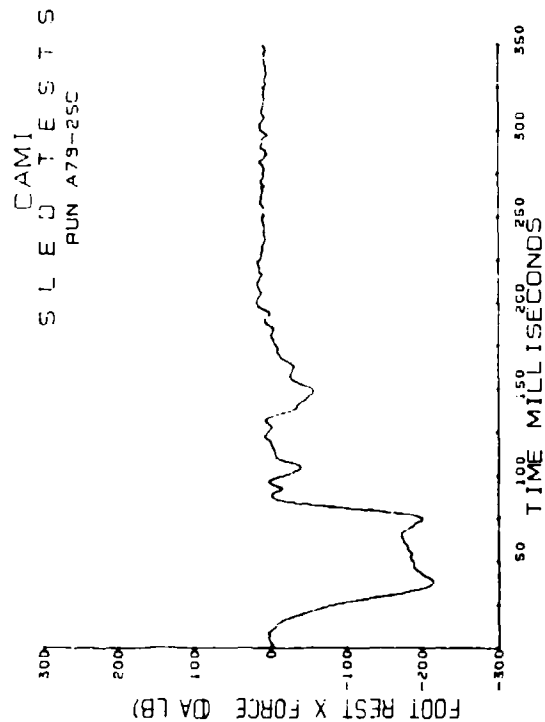


CAMI
S L E D T E S T S
RUN A79-25B

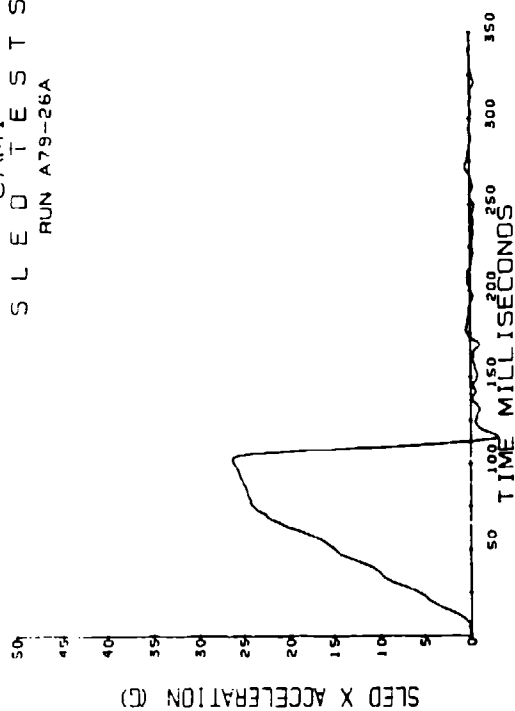


CAMI
S L E D T E S T S
RUN A79-25B

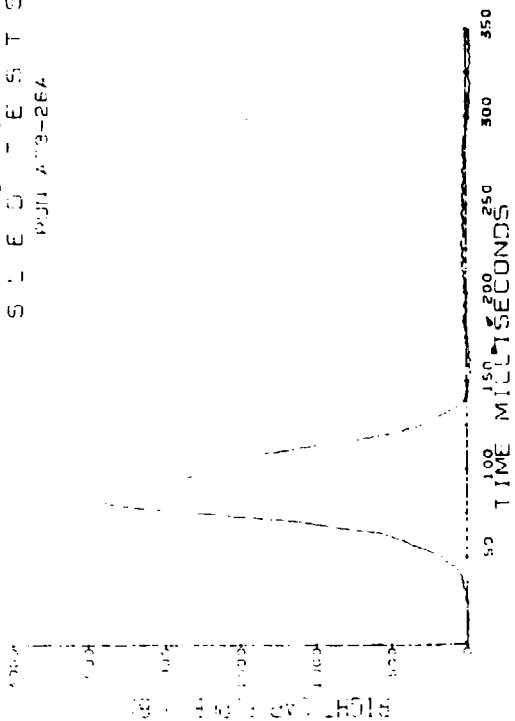




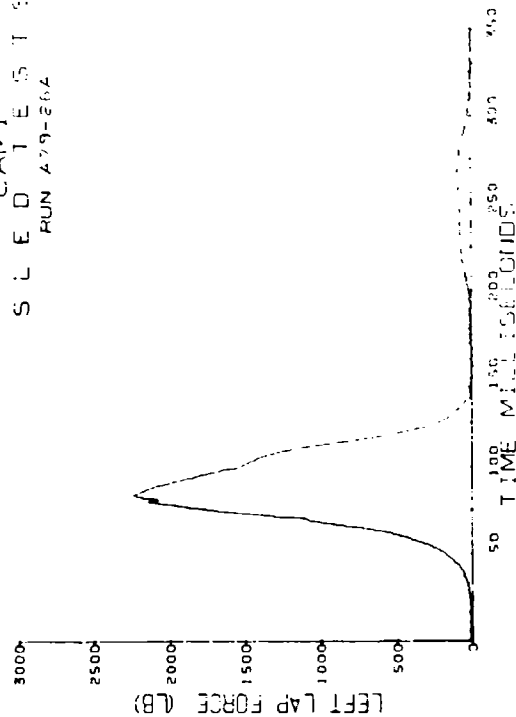
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RUN A79-26A



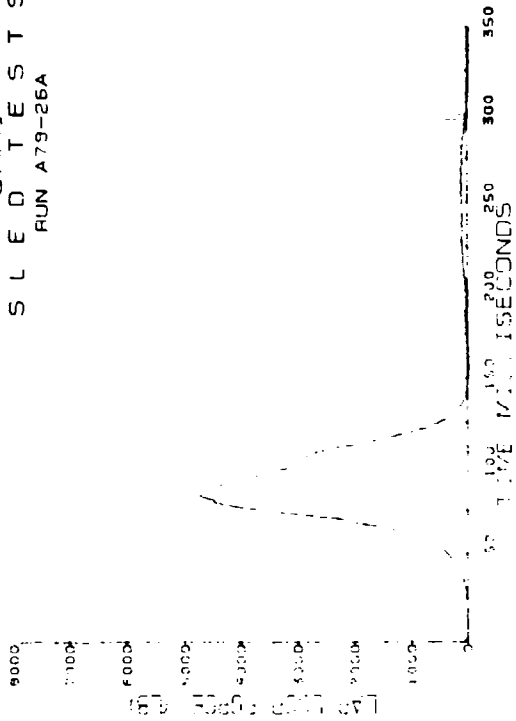
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RUN A79-26A



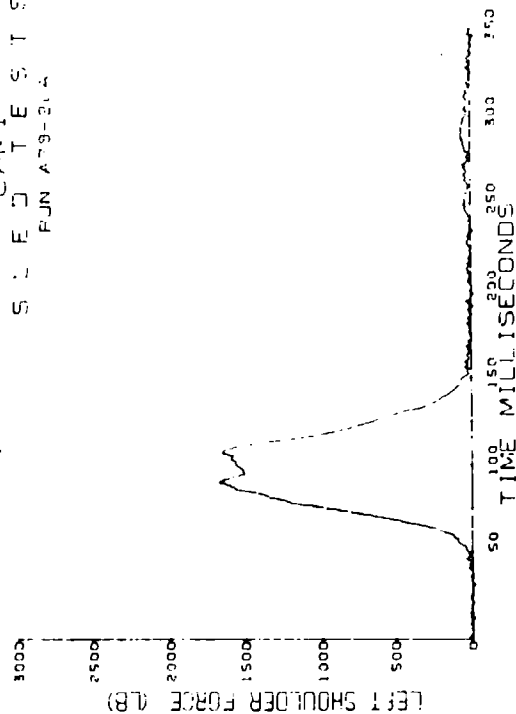
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RUN A79-26A



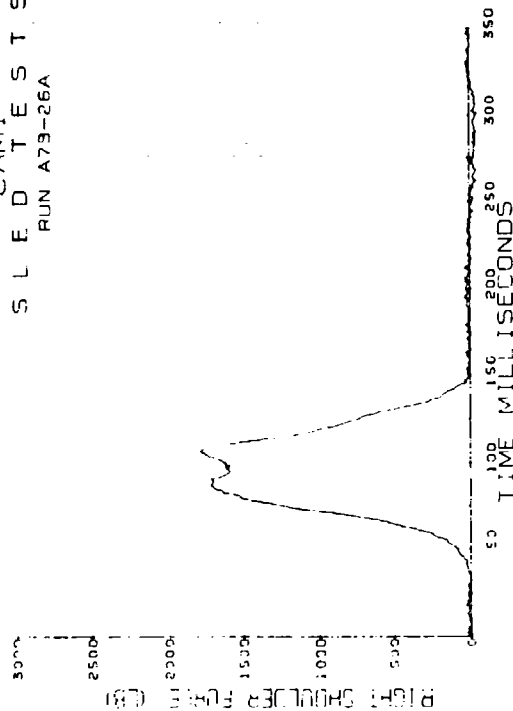
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S L E D T E S T S
RUN A79-26A



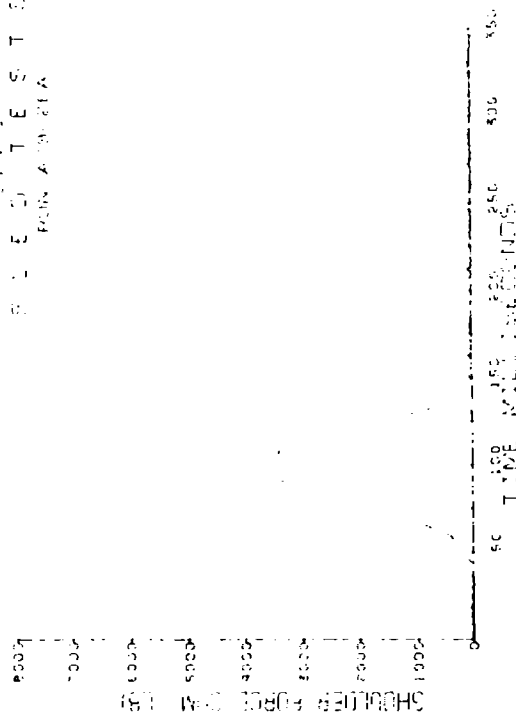
CAMI
S L E D T E S T S
RUN A79-26A

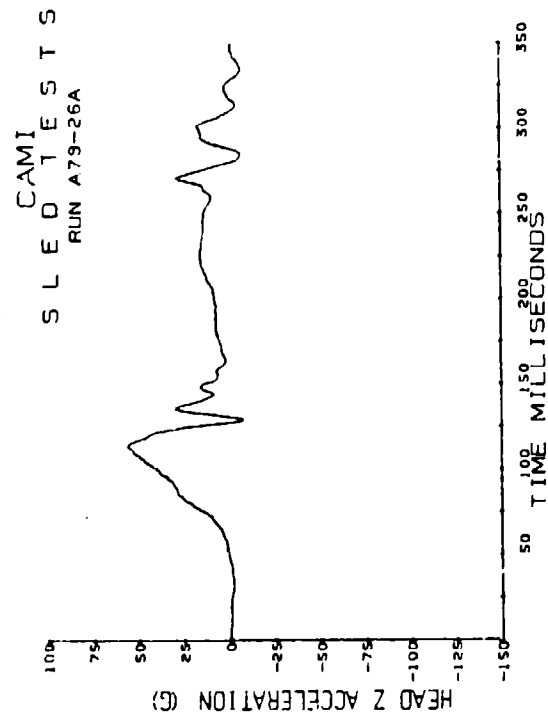
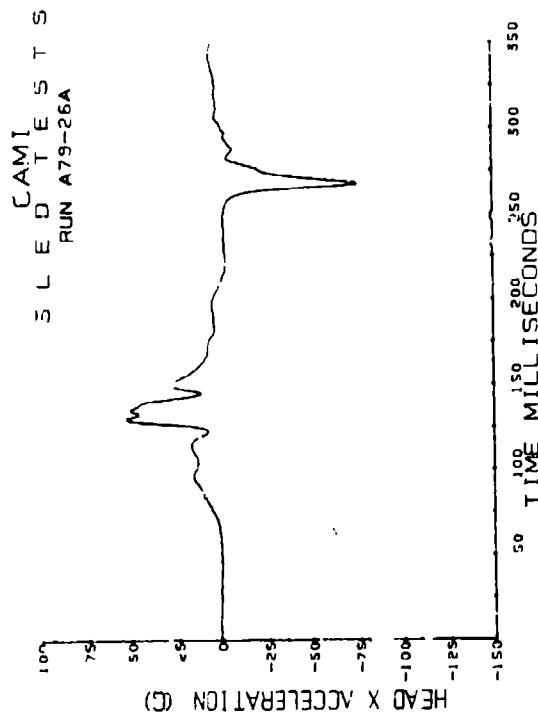
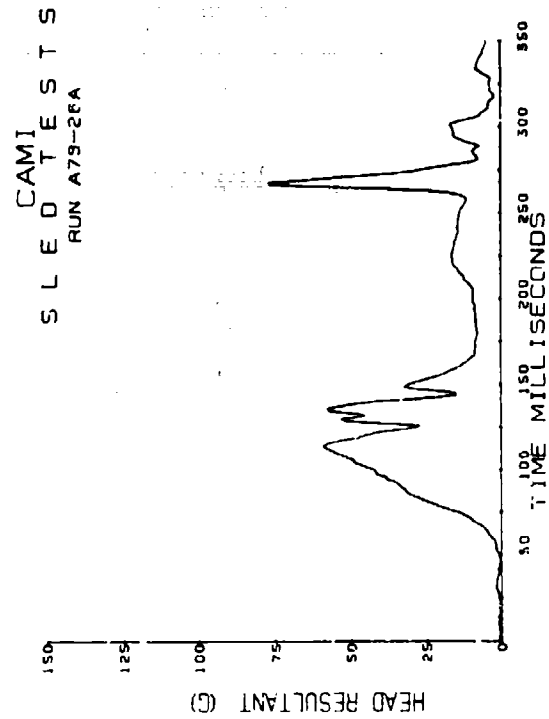
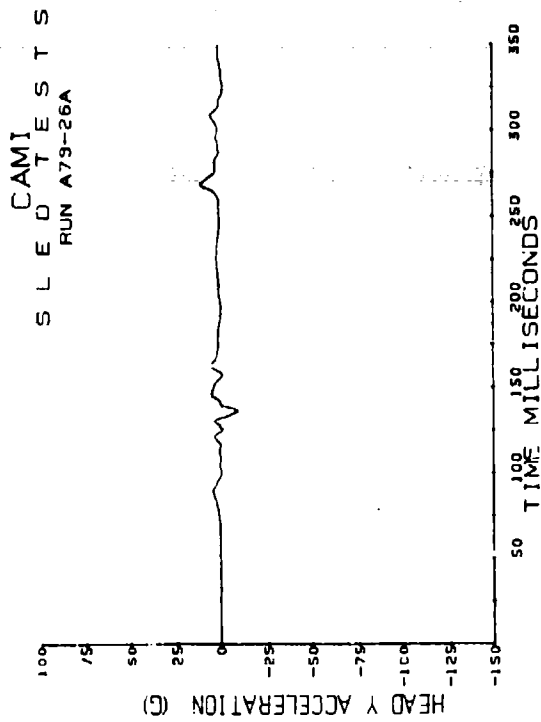


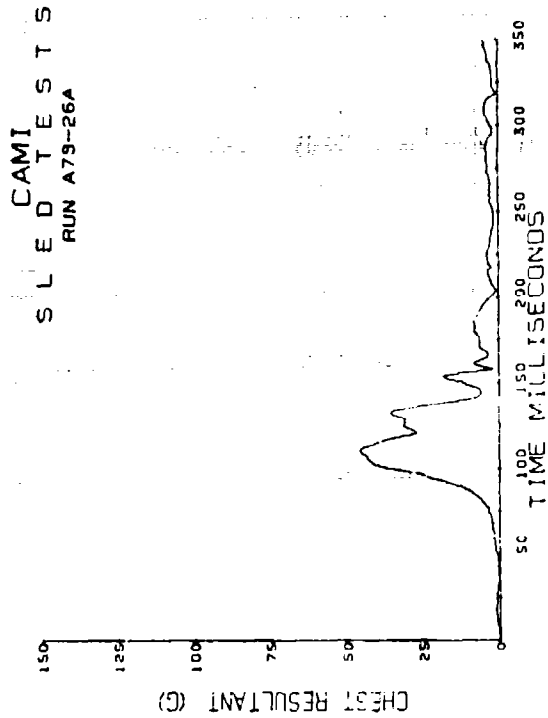
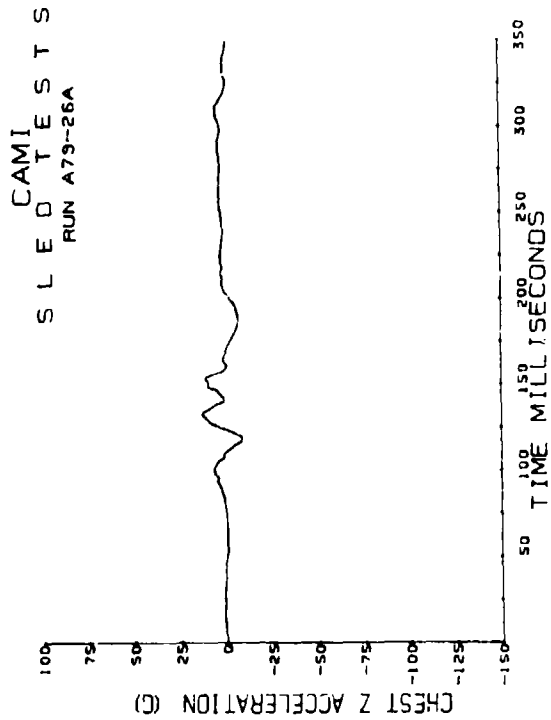
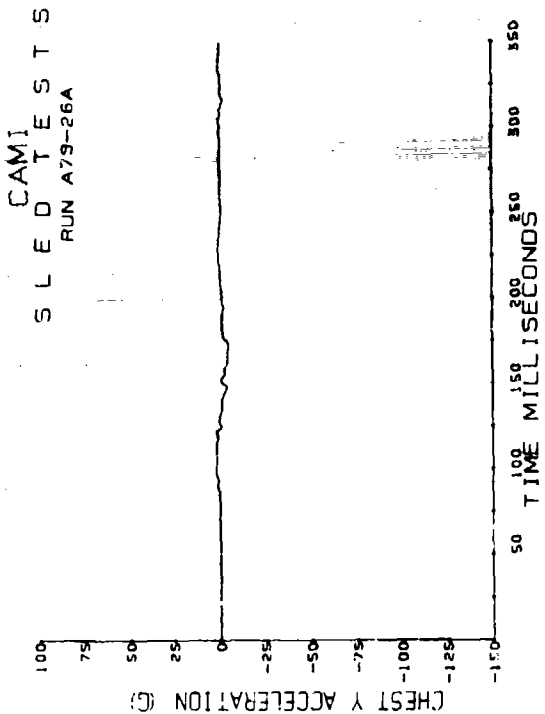
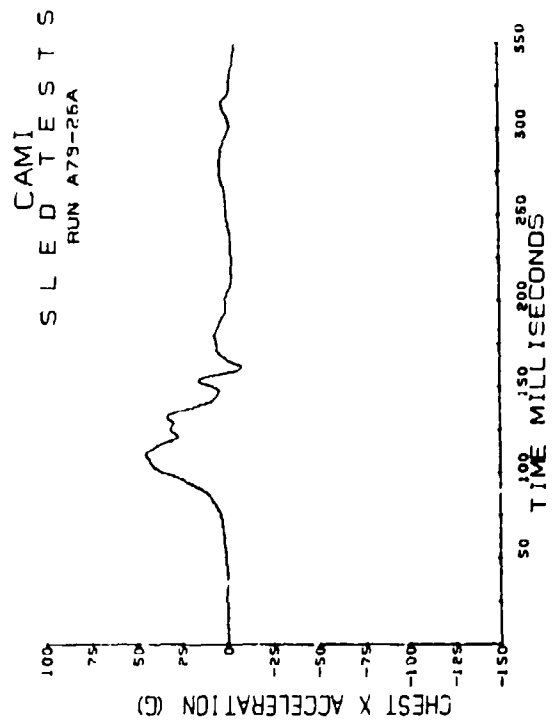
CAMI
S L E D T E S T S
RUN A79-26A

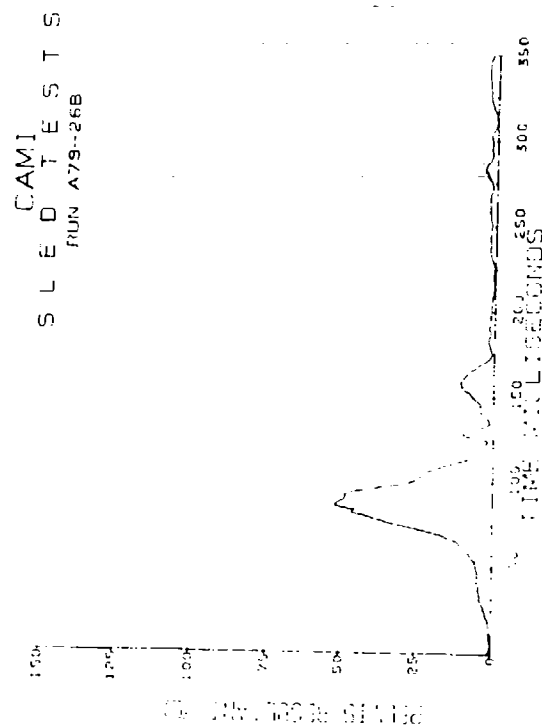
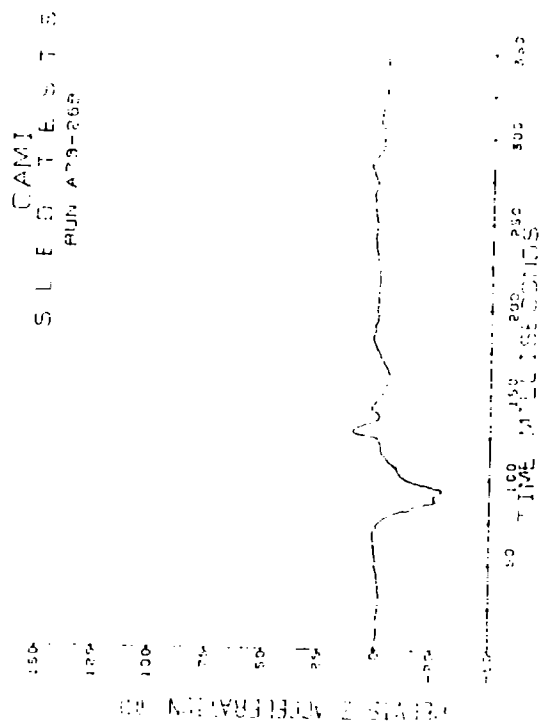
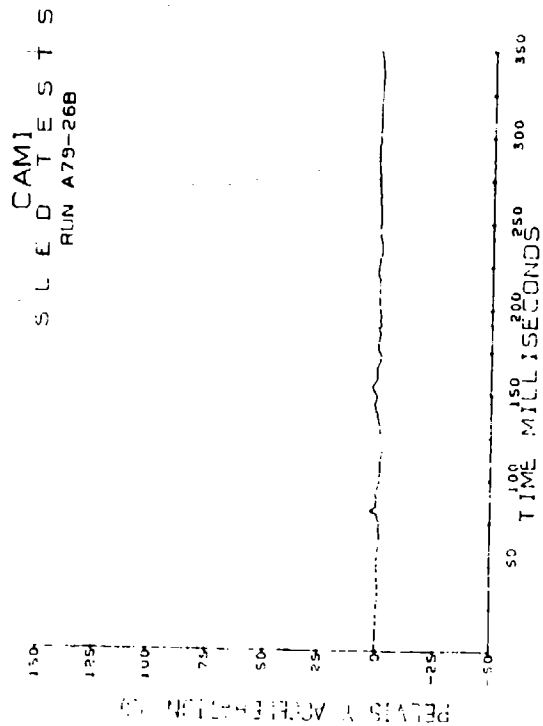
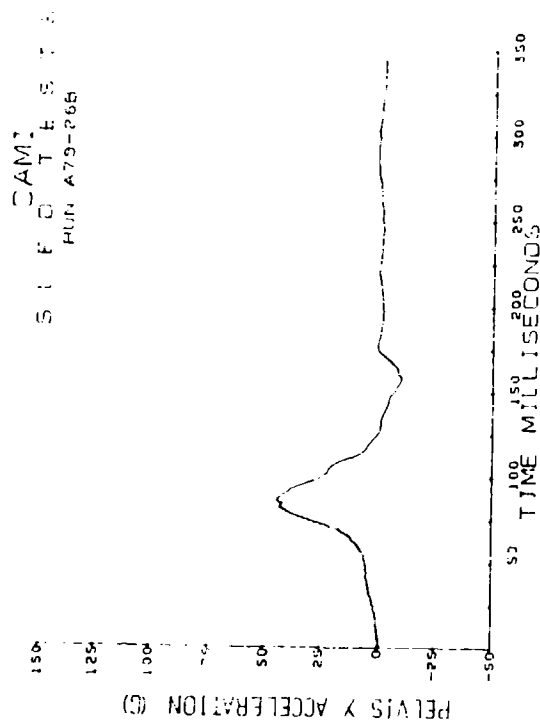


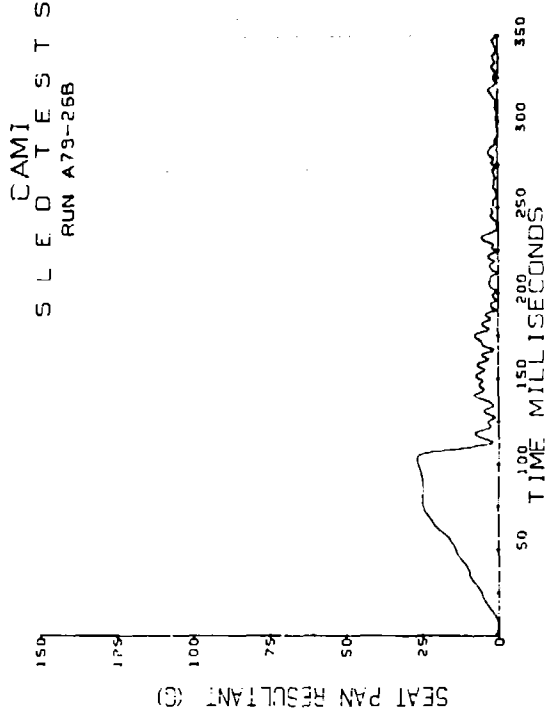
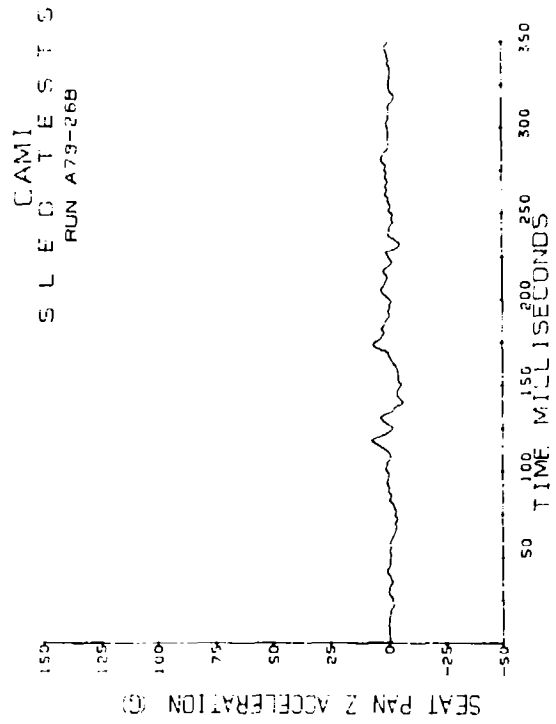
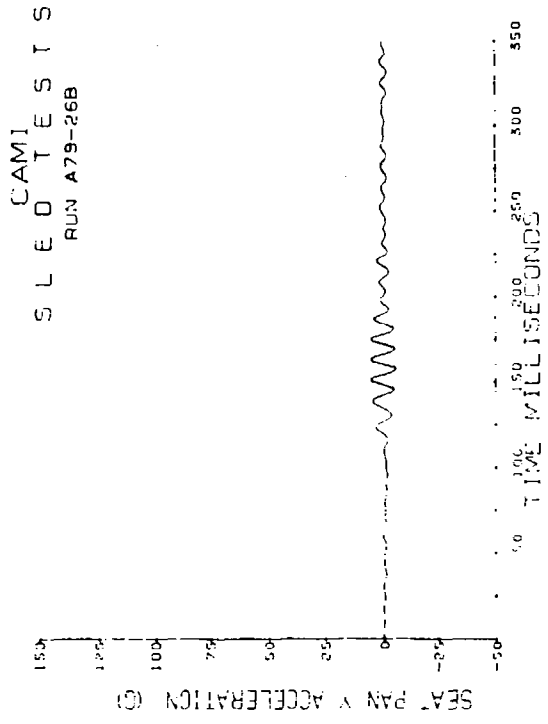
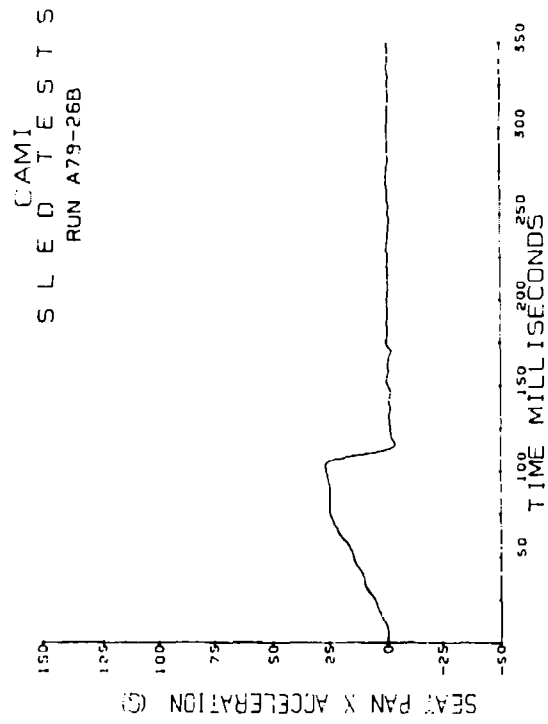
CAMI
S L E D T E S T S
RUN A79-26A



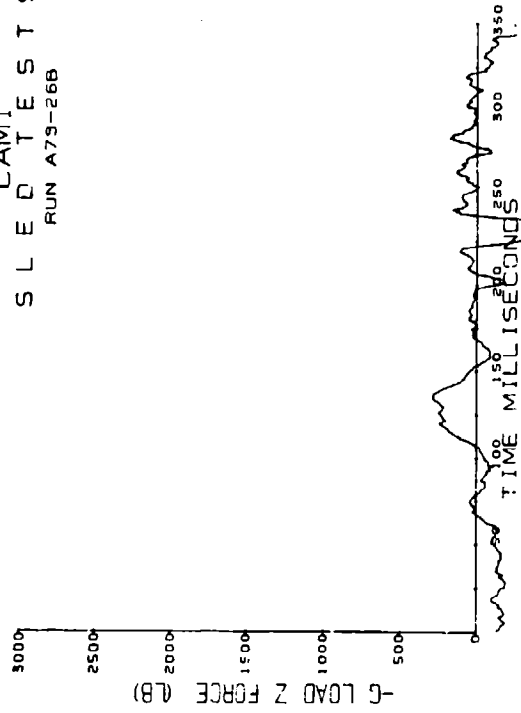




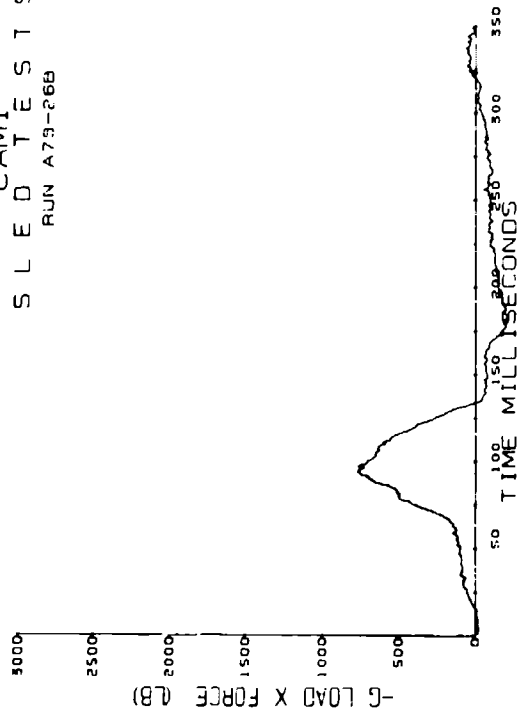




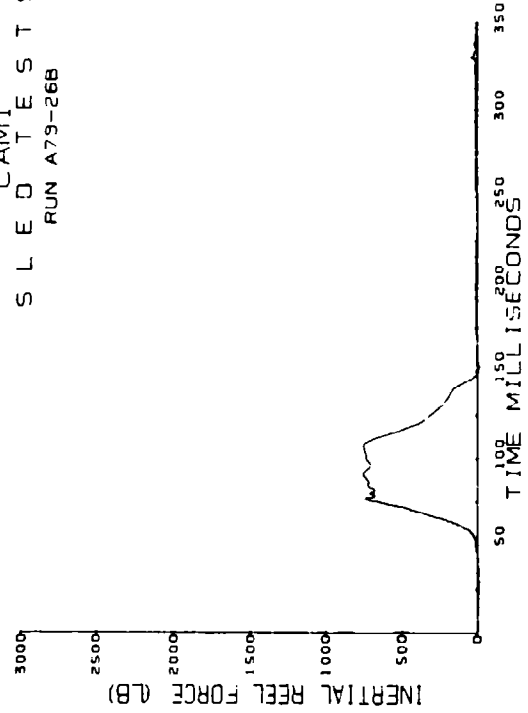
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S L E D T E S T S
RUN A79-268

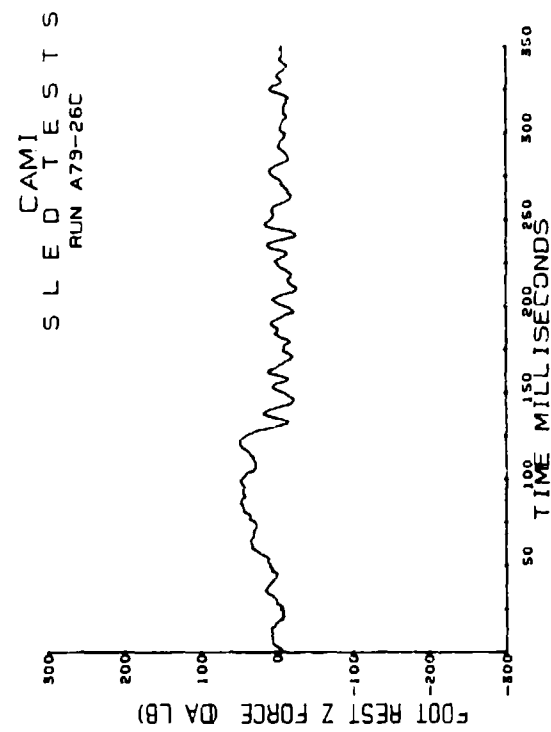
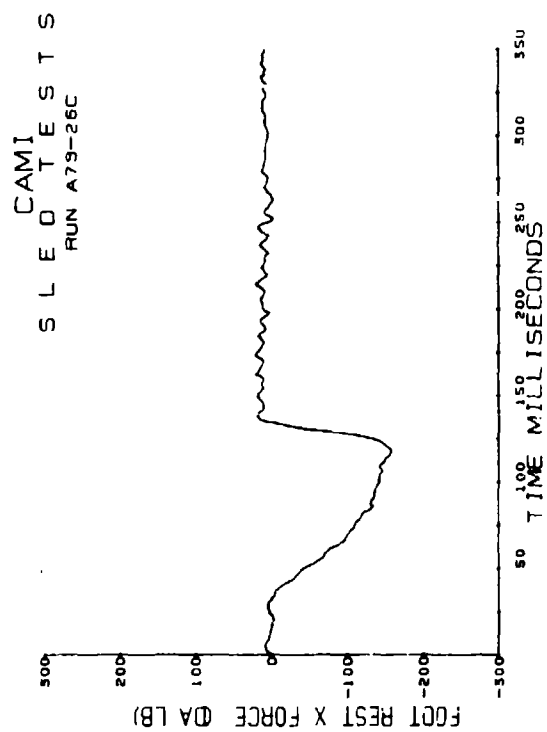
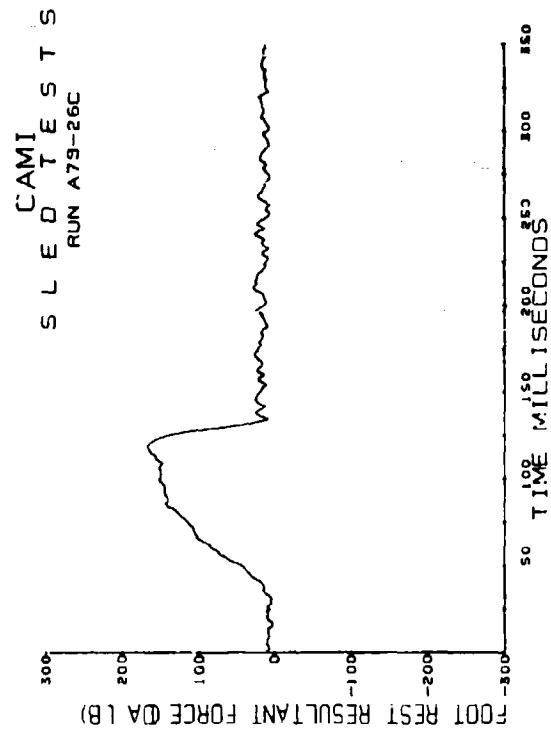
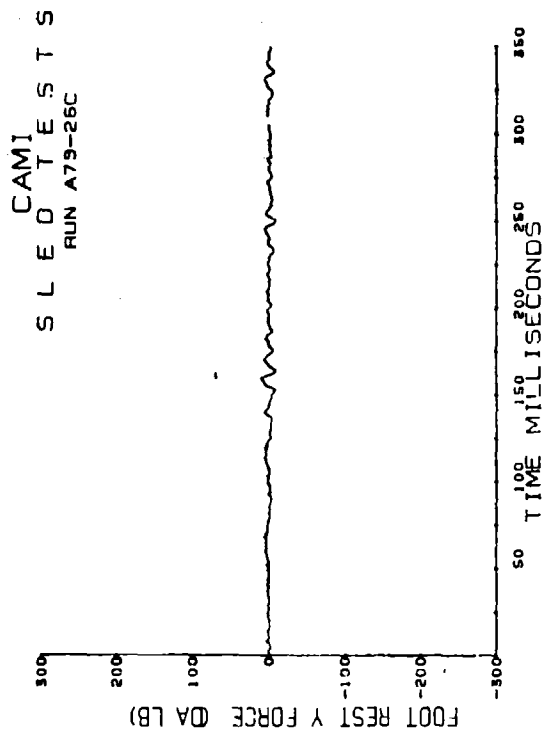


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S L E D T E S T S
RUN A79-268

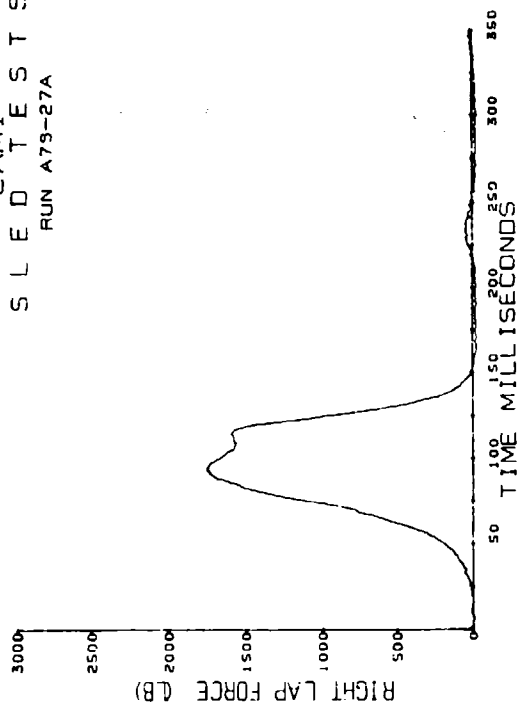


CAMI
S L E D T E S T S
RUN A79-268

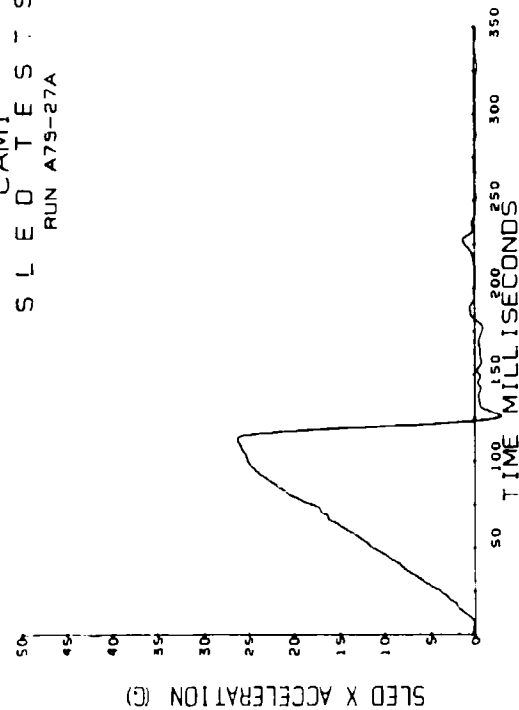




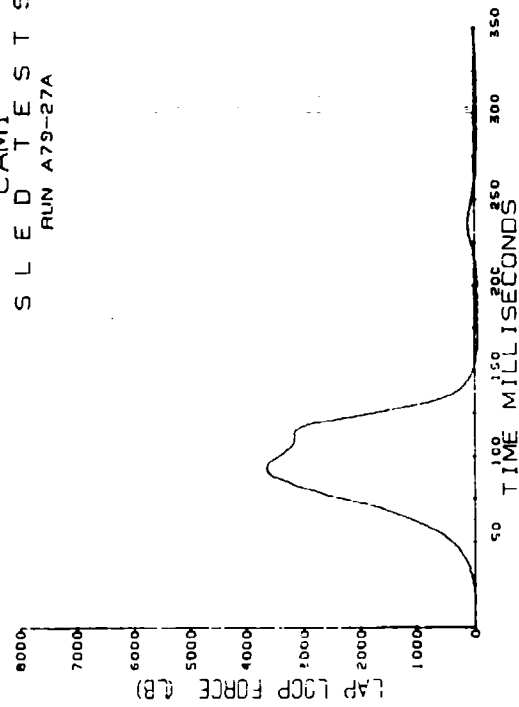
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S L E D T E S T S
RUN A79-27A



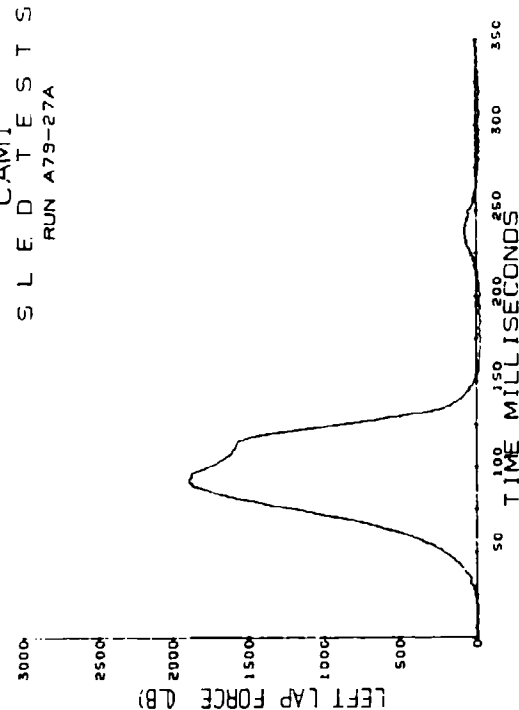
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S L E D T E S T S
RUN A79-27A



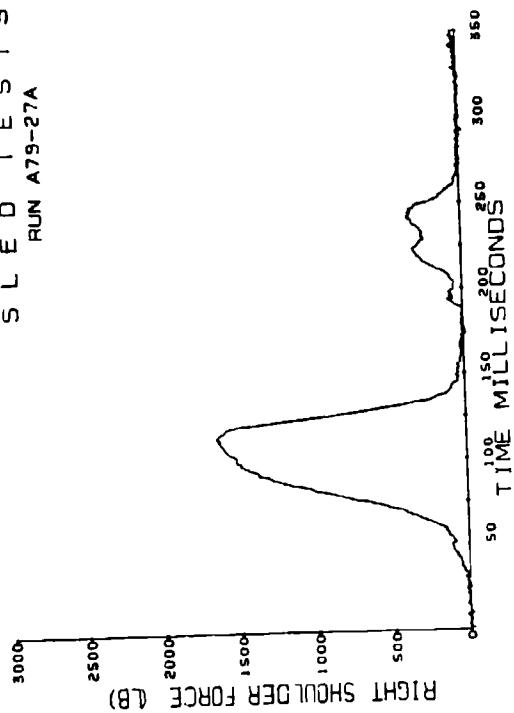
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S L E D T E S T S
RUN A79-27A



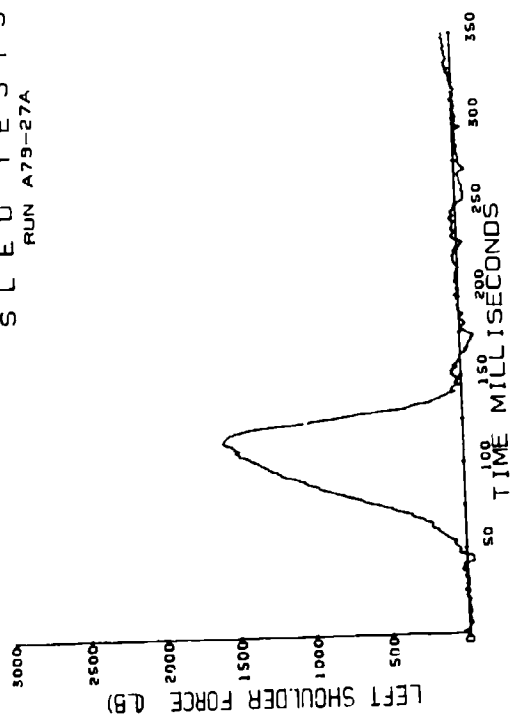
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S L E D T E S T S
RUN A79-27A



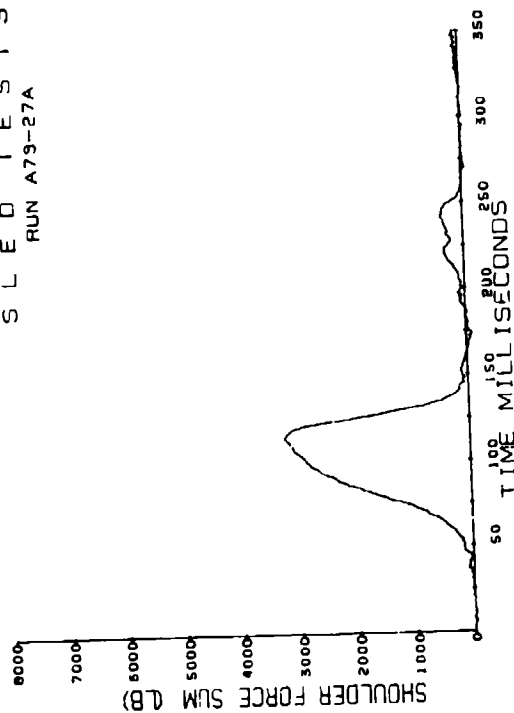
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S L E D T E S T S
RUN A79-27A

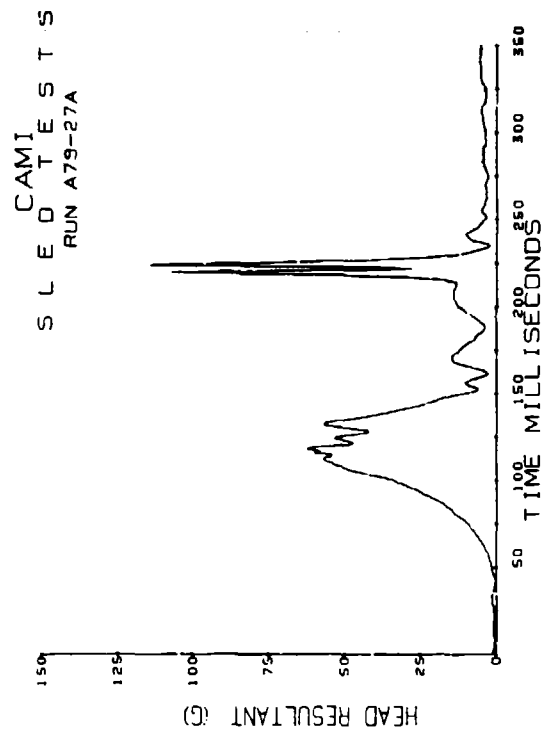
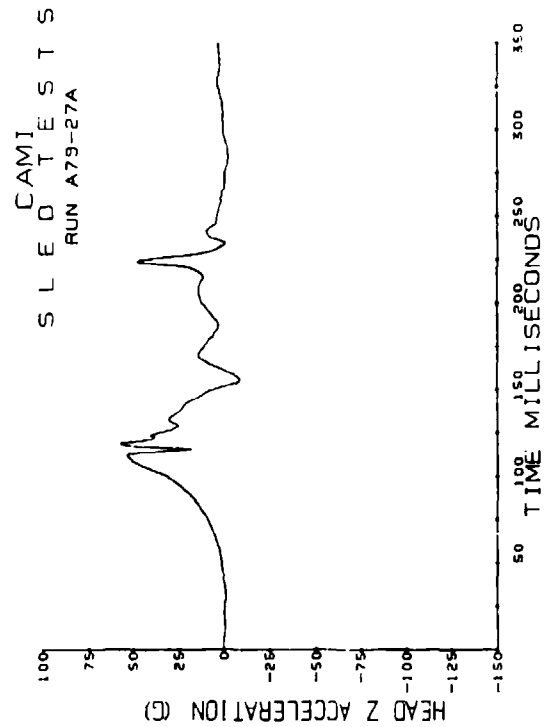
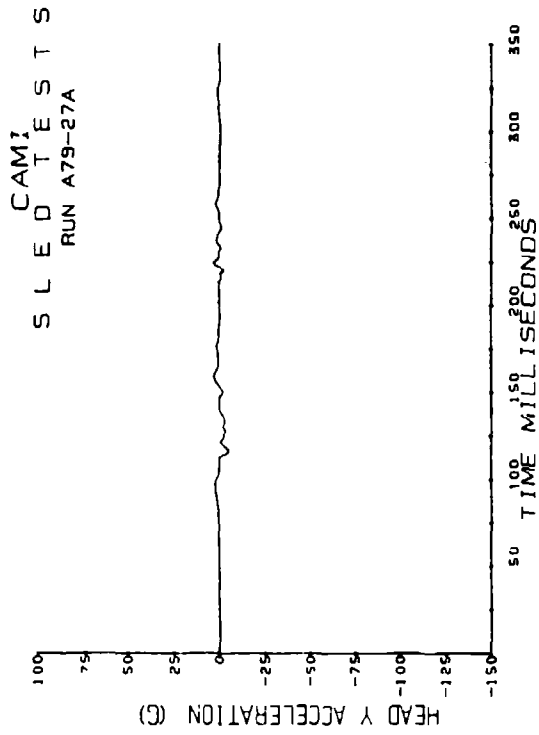
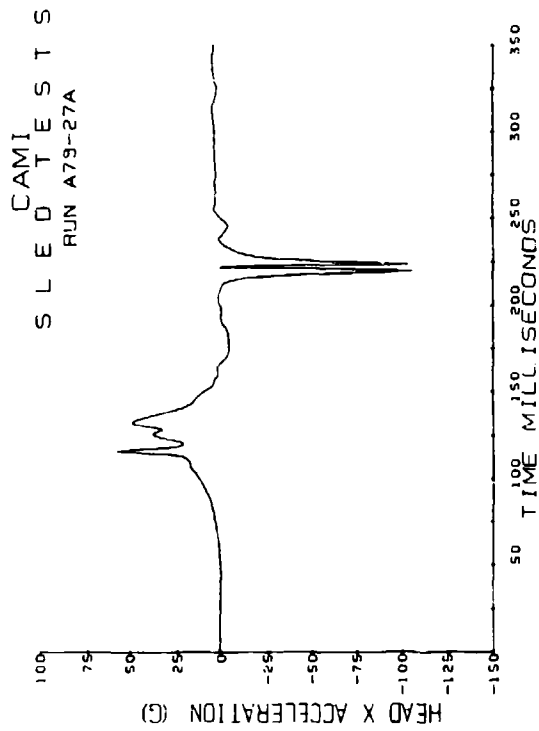


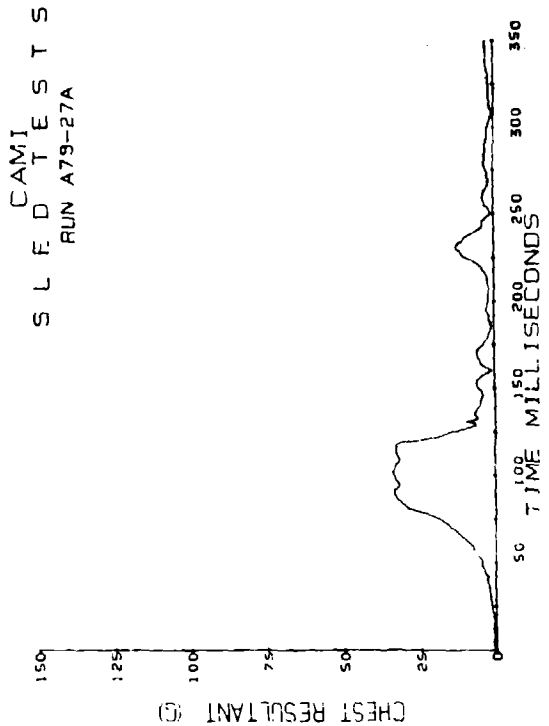
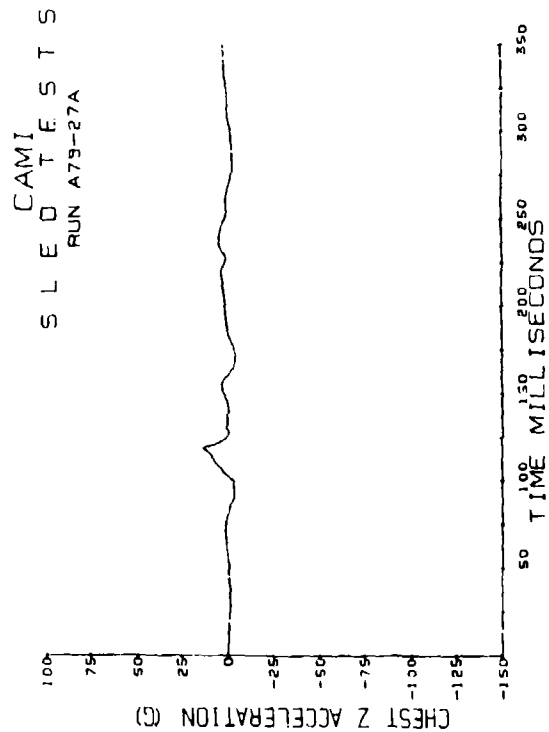
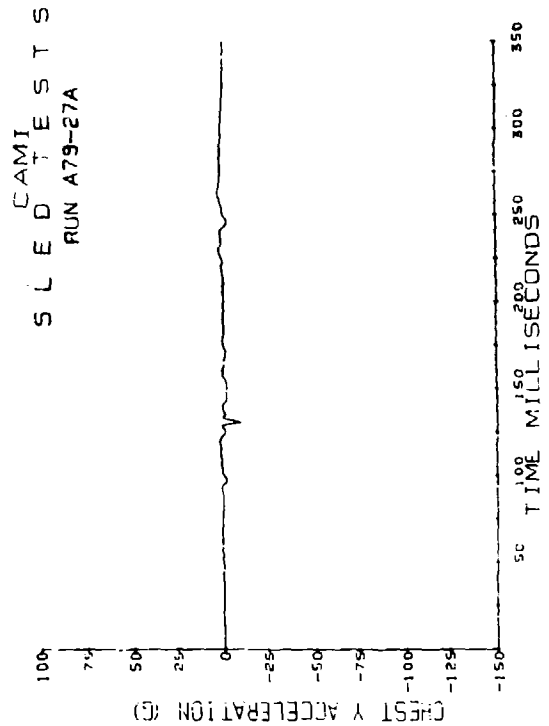
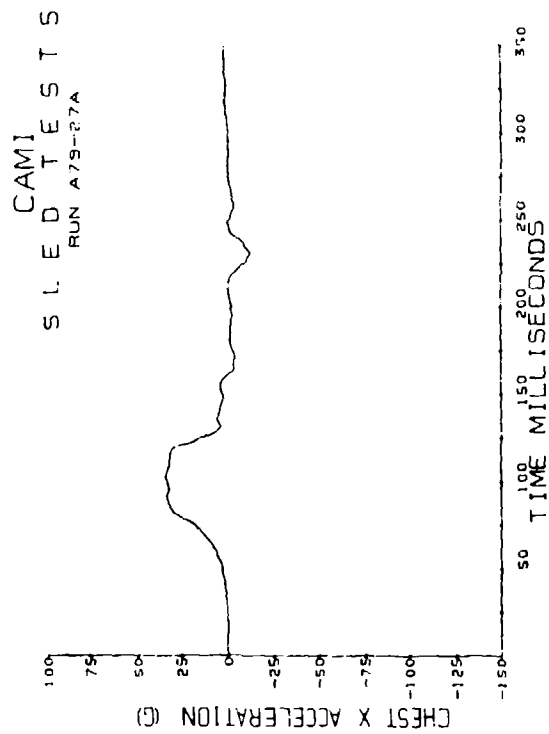
CAMI
S L E D T E S T S
RUN A79-27A



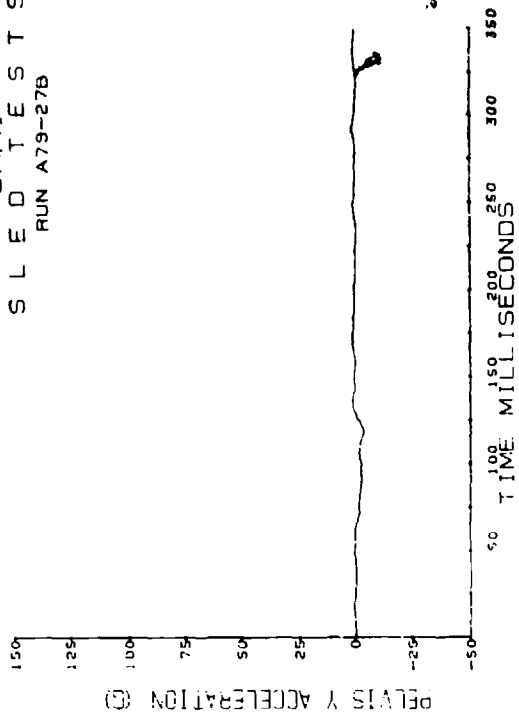
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S L E D T E S T S
RUN A79-27A



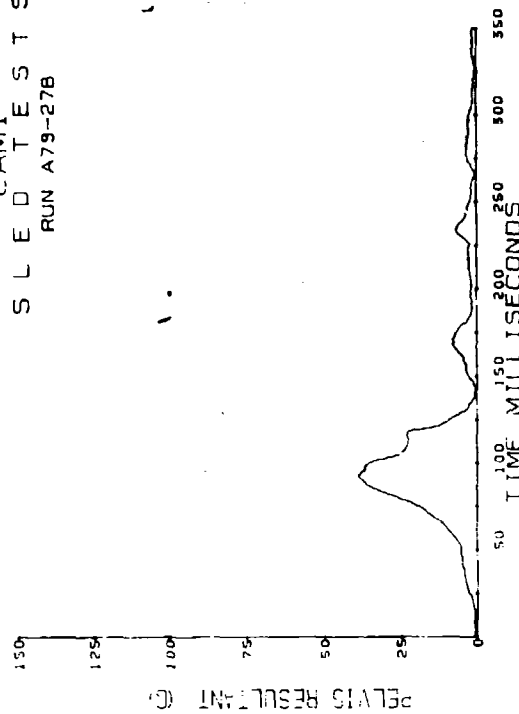




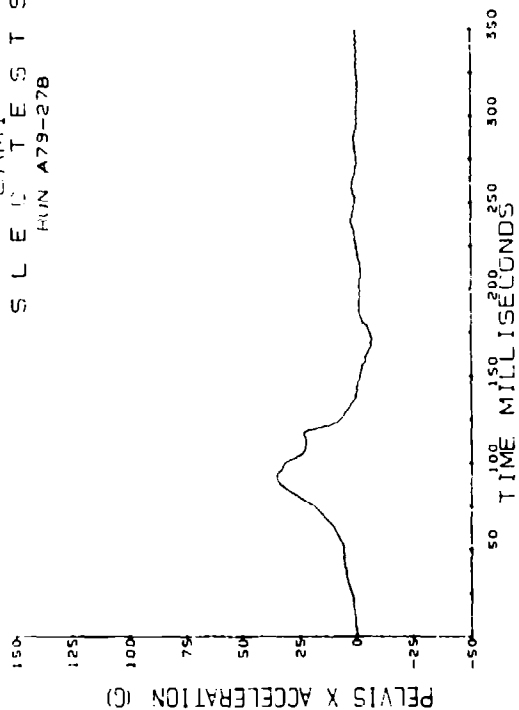
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S L E D T E S T S
RUN A79-27B



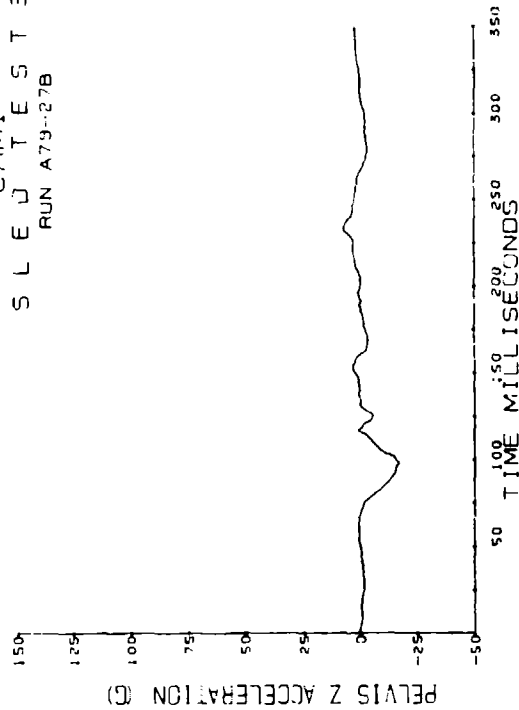
CAMI
S L E D T E S T S
RUN A79-27B

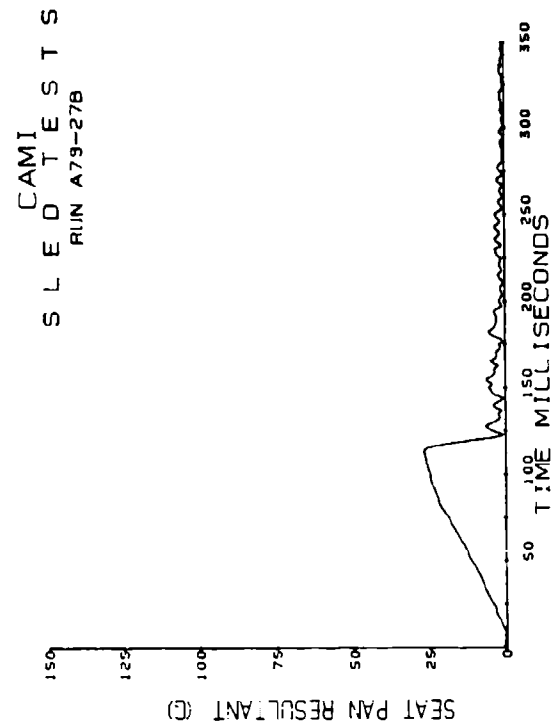
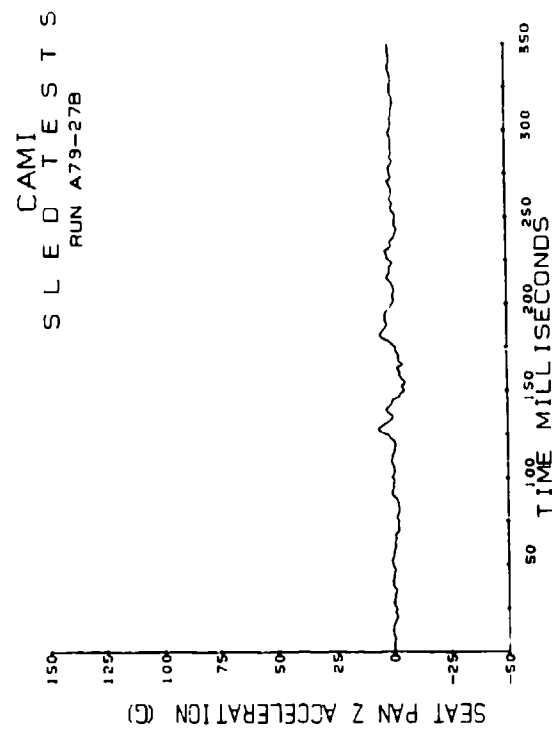
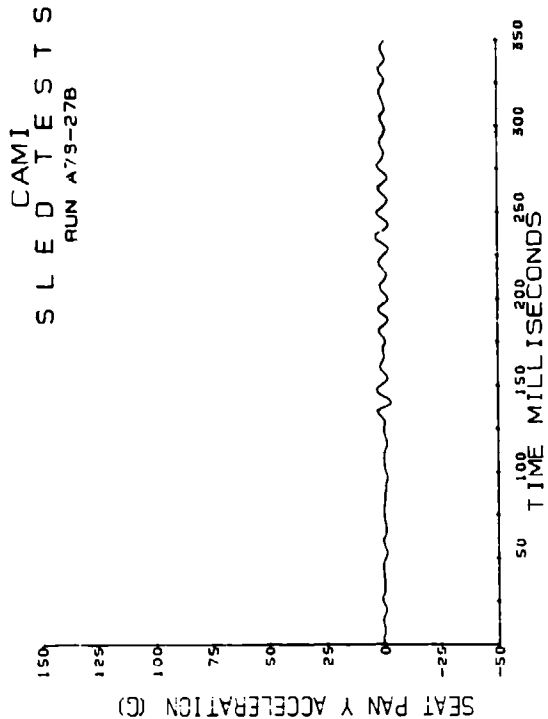
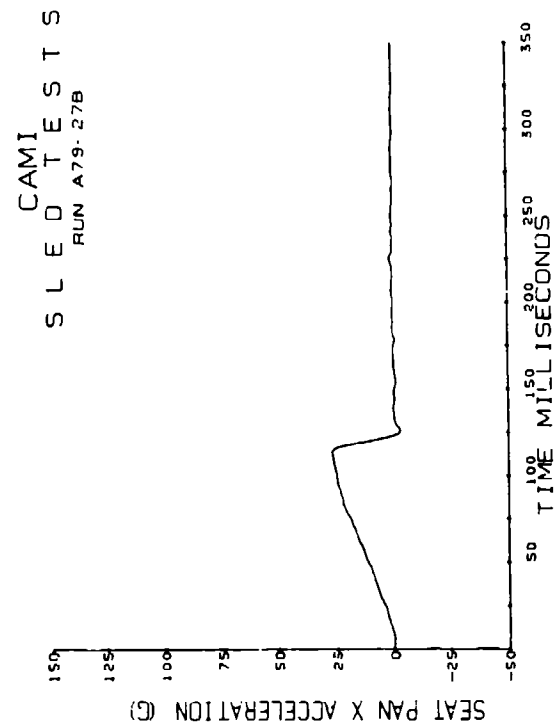


CAMI
S L E D T E S T S
RUN A79-27B



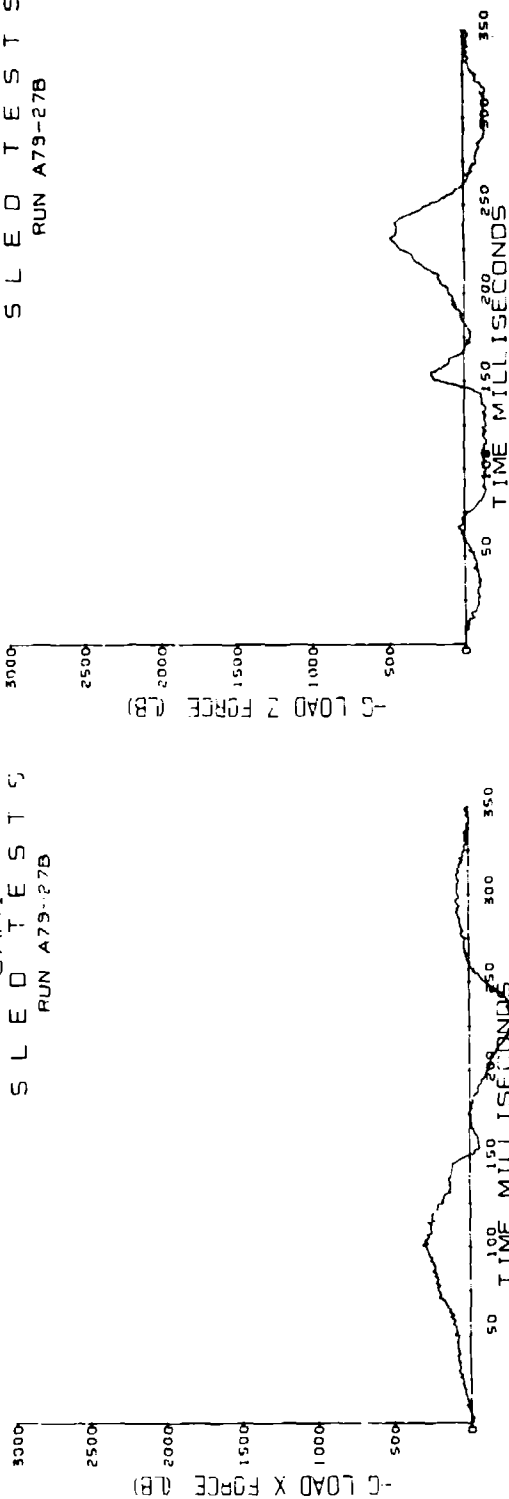
CAMI
S L E D T E S T S
RUN A79-27B



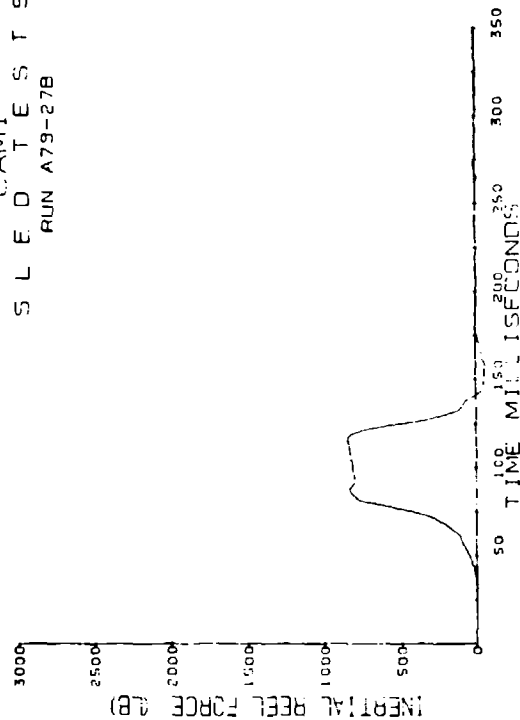


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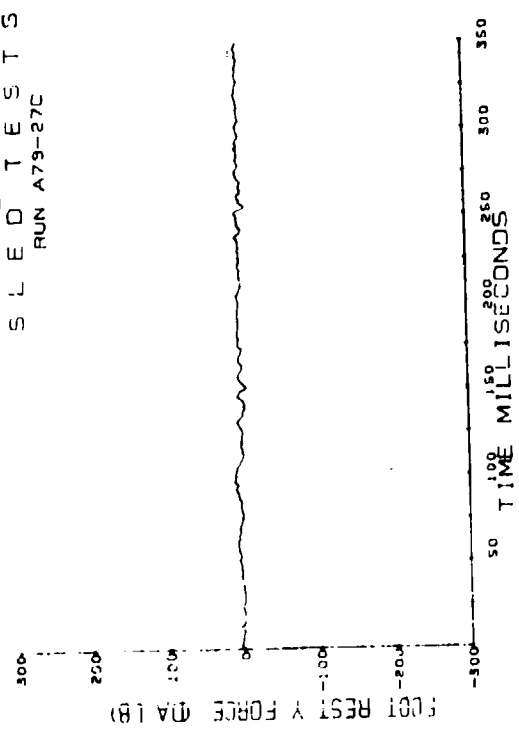
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S L E D T E S T S
RUN A79-27B



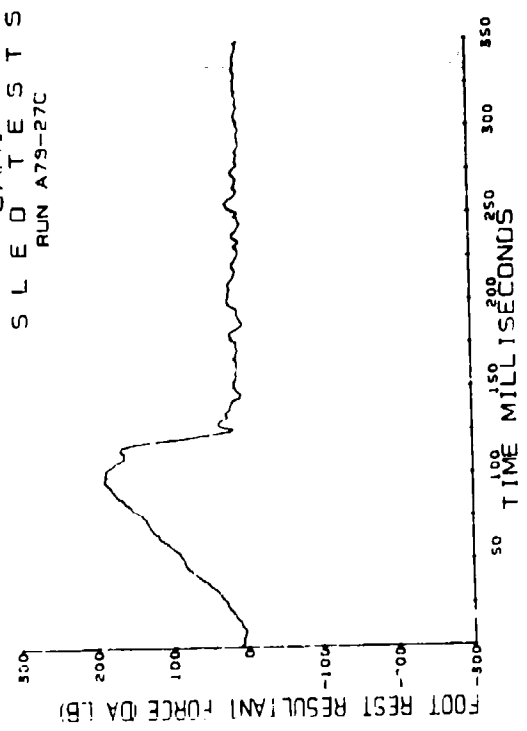
CAMI
S L E D T E S T S
RUN A79-27B



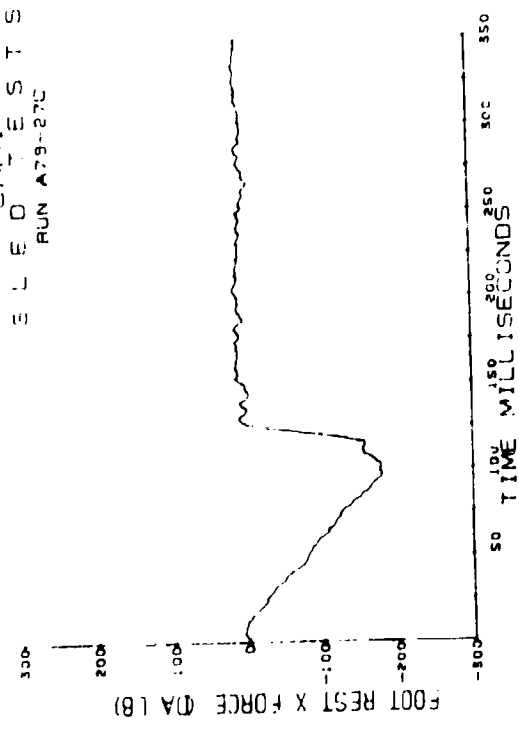
CAMI
S L E D T E S T S
RUN A79-27C



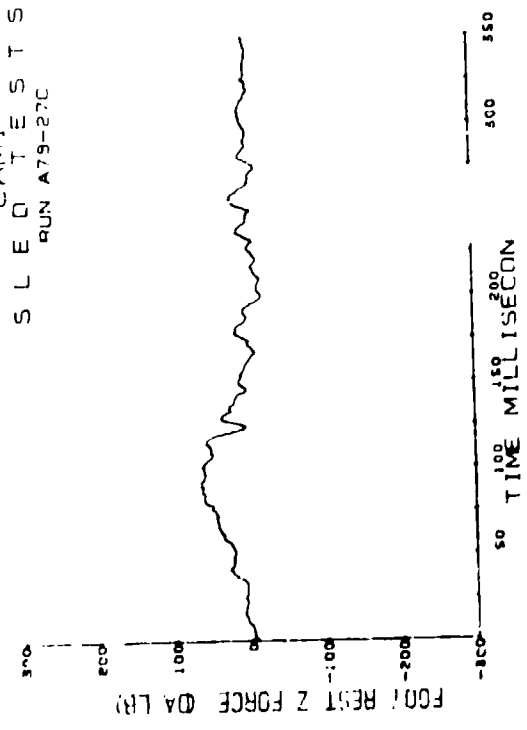
CAMI
S L E D T E S T S
RUN A79-27C

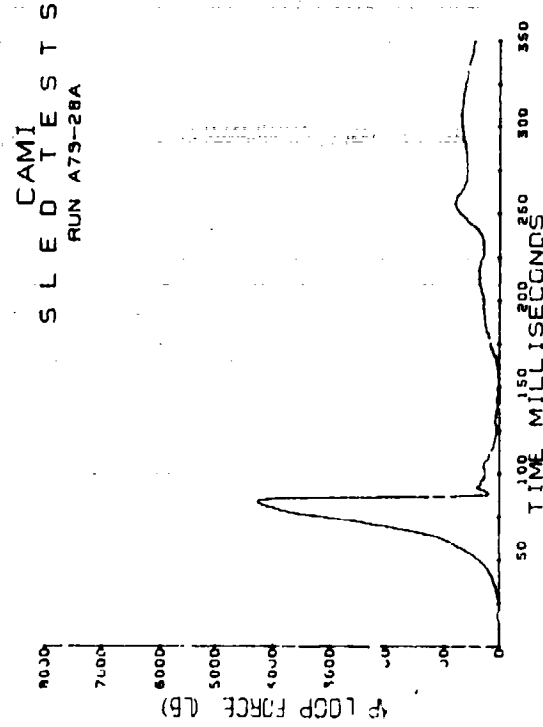
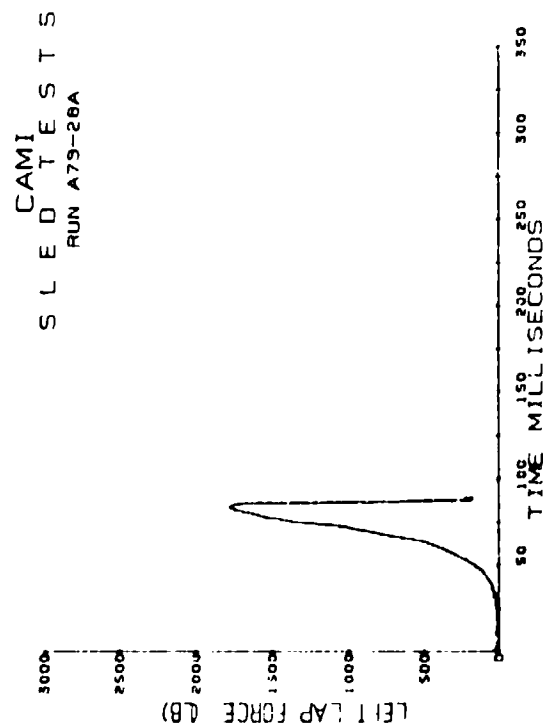
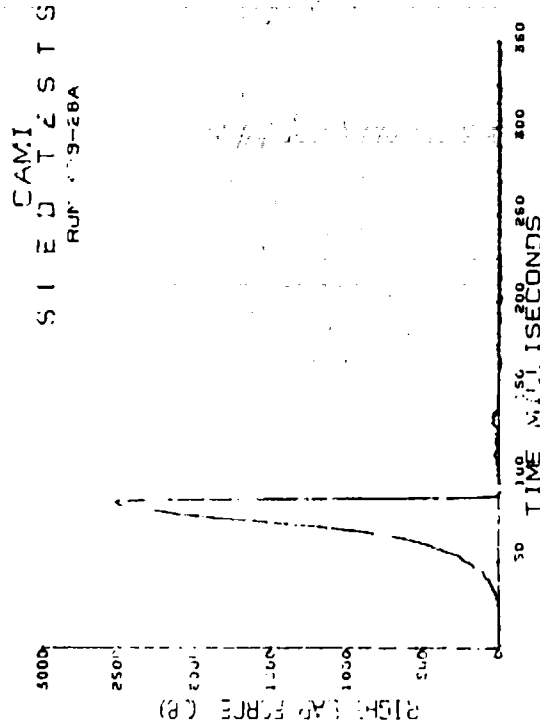
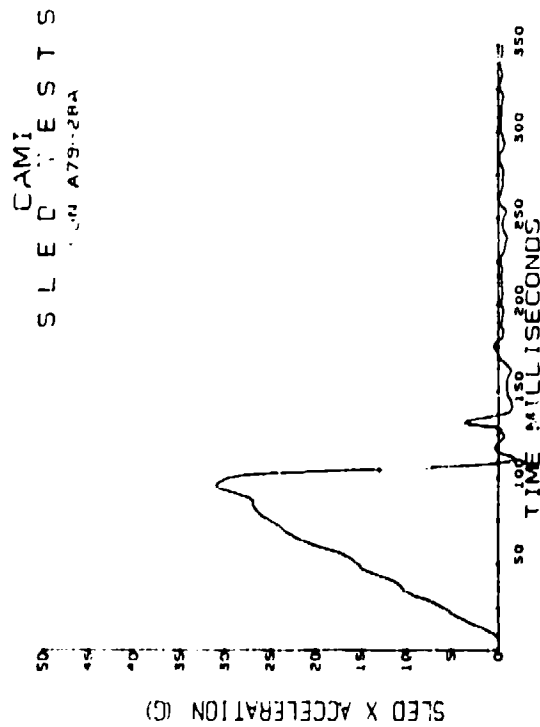


CAMI
S L E D T E S T S
RUN A79-27C

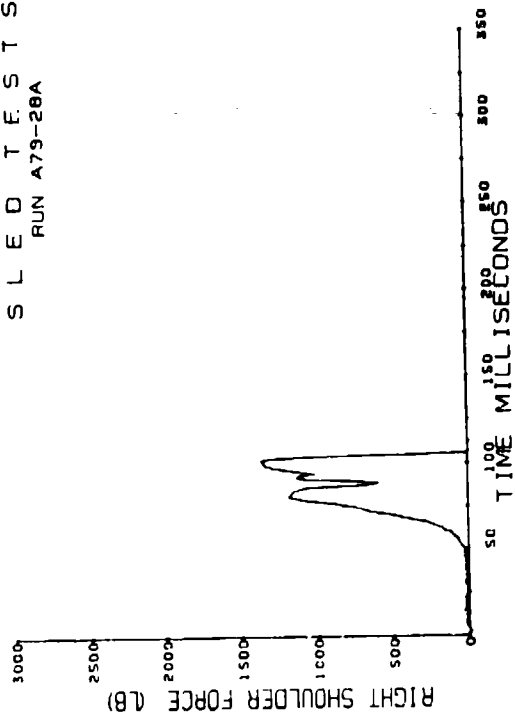


CAMI
S L E D T E S T S
RUN A79-27C

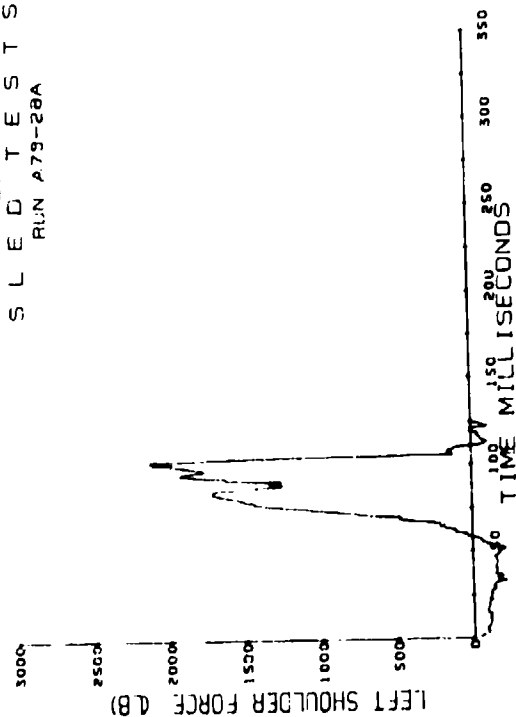




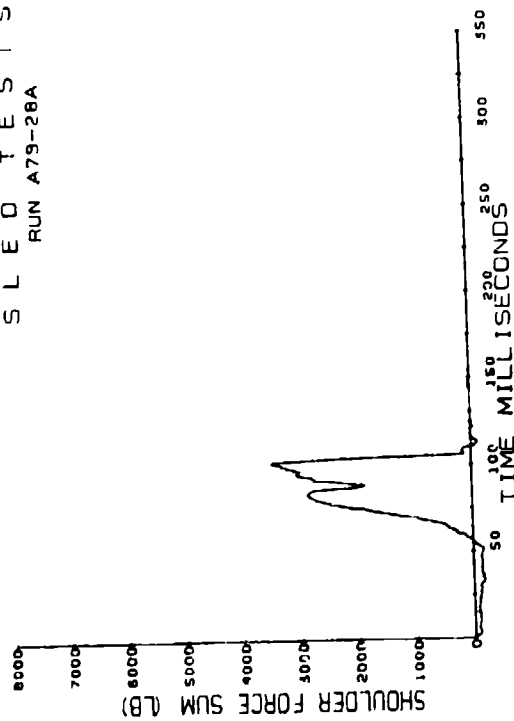
CAMI
S L E D T E S T S
RUN A79-28A



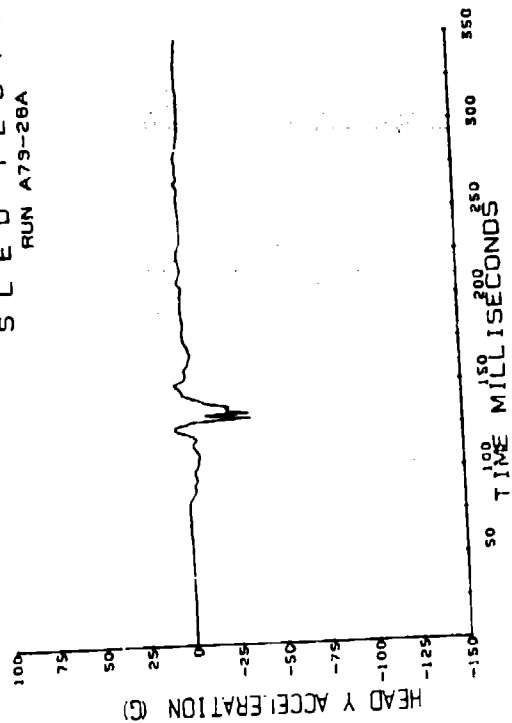
CAMI
S L E D T E S T S
RUN A79-28A



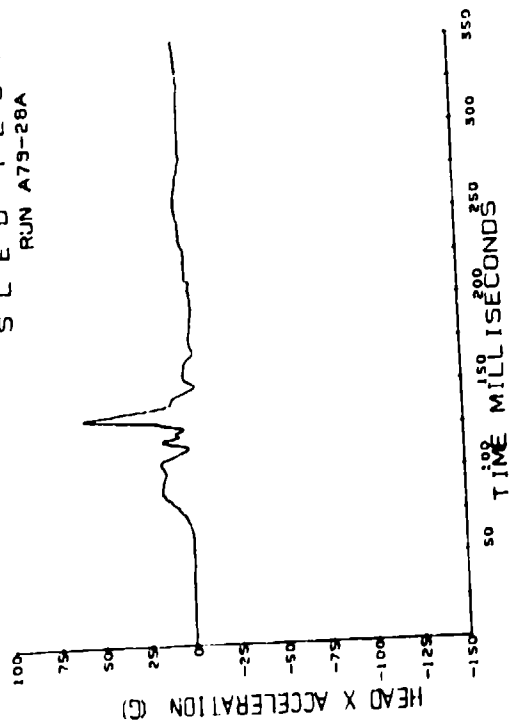
CAMI
S L E D T E S T S
RUN A79-28A



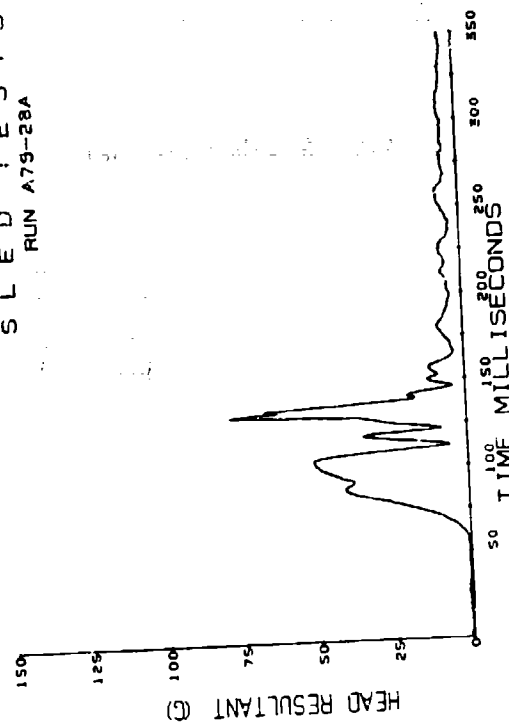
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S L E D T E S T S
RUN A79-28A



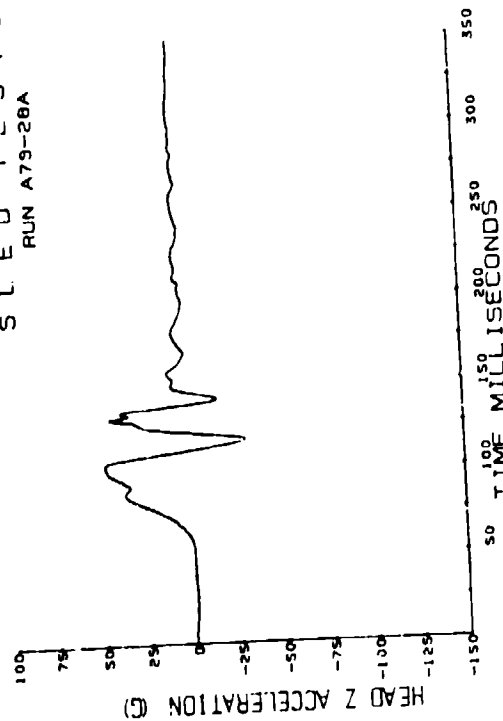
CAMI
S L E D T E S T S
RUN A79-28A

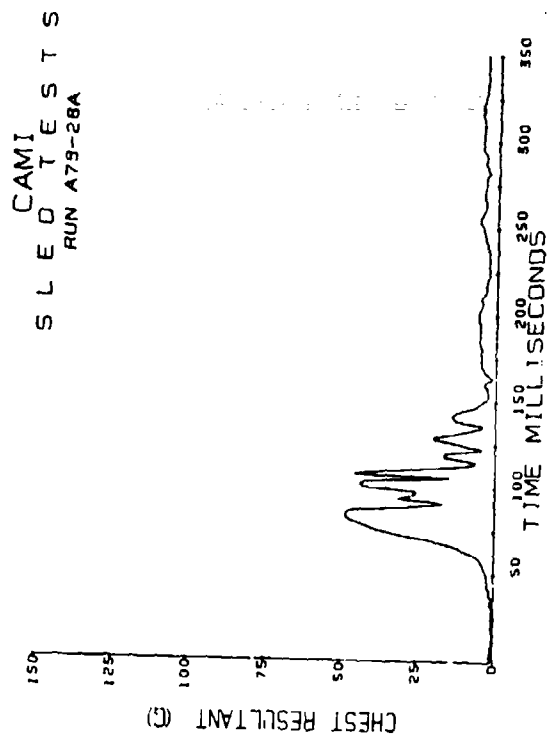
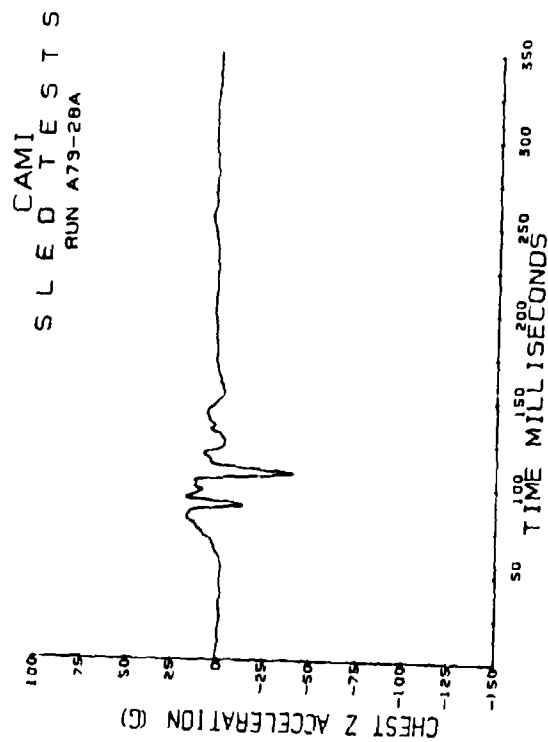
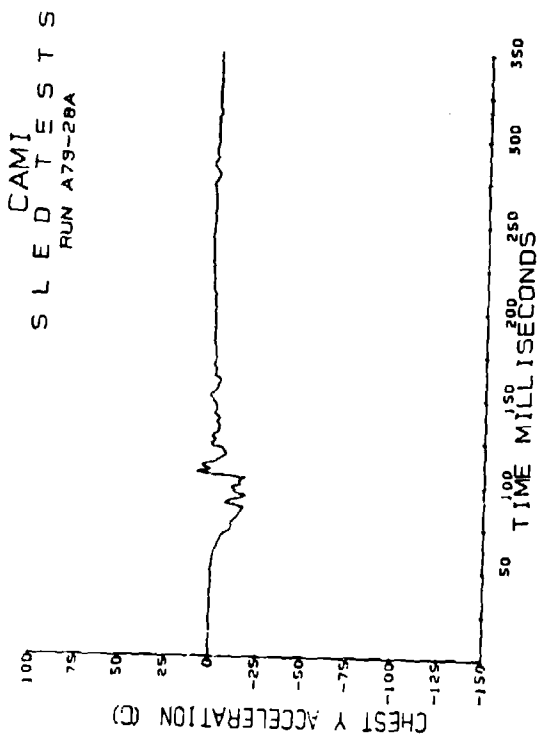
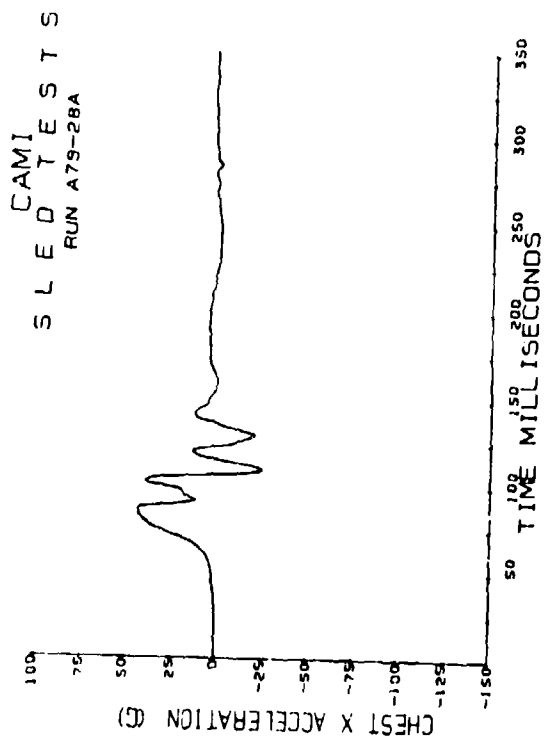


CAMI
S L E D T E S T S
RUN A79-28A

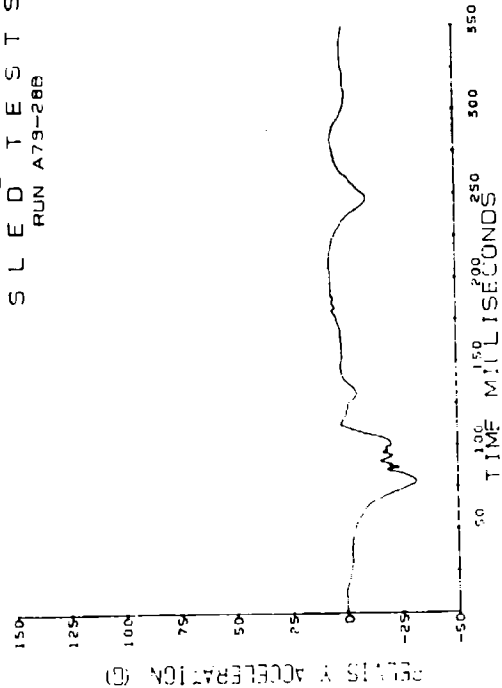


CAMI
S L E D T E S T S
RUN A79-28A

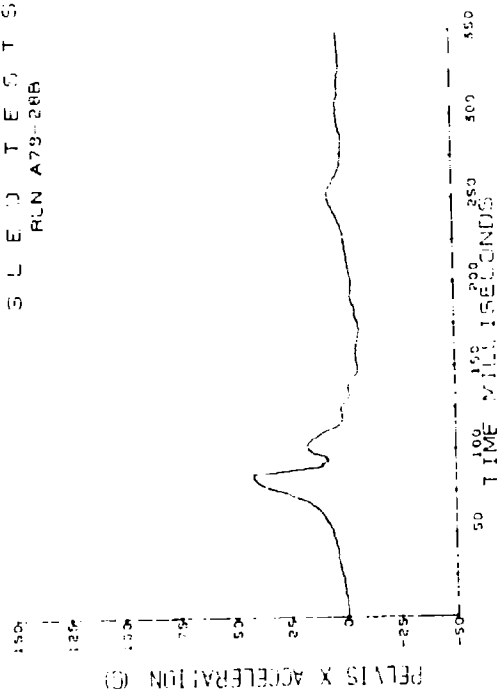




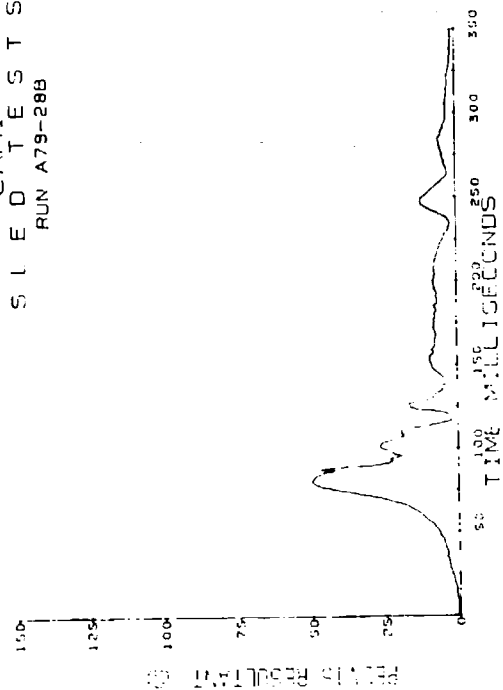
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S L E D T E S T S
RUN A79-28B



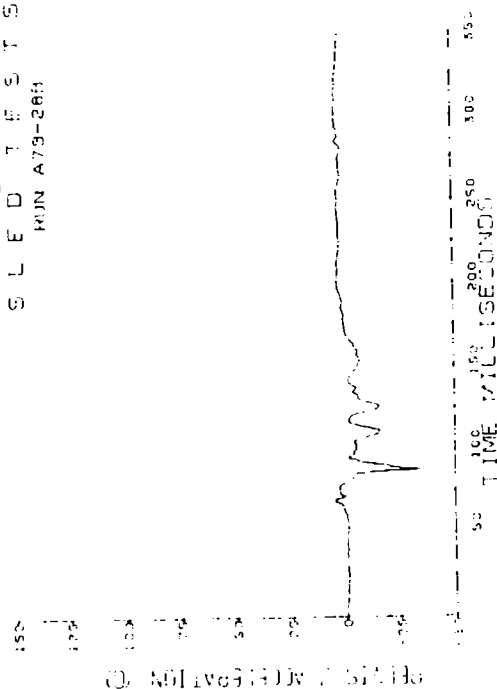
CAMI
S L E D T E S T S
RUN A79-28B



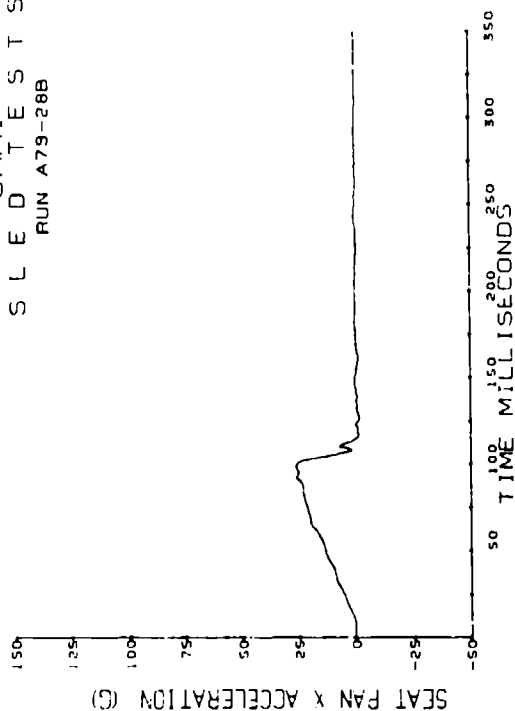
CAMI
S L E D T E S T S
RUN A79-28B



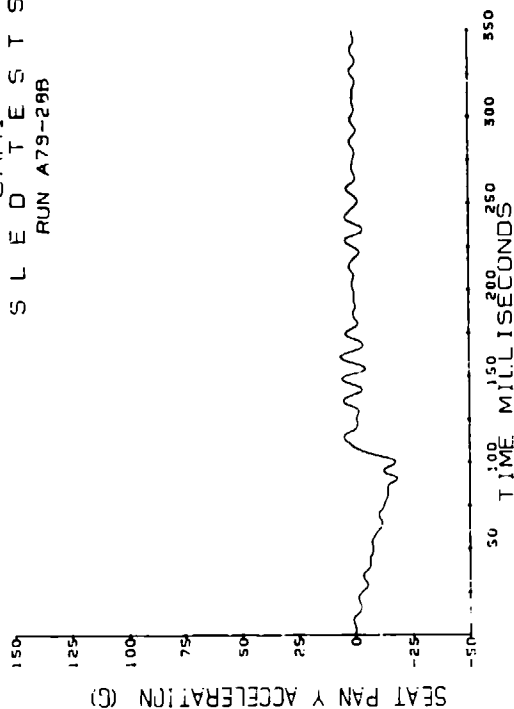
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S L E D T E S T S
RUN A79-28B



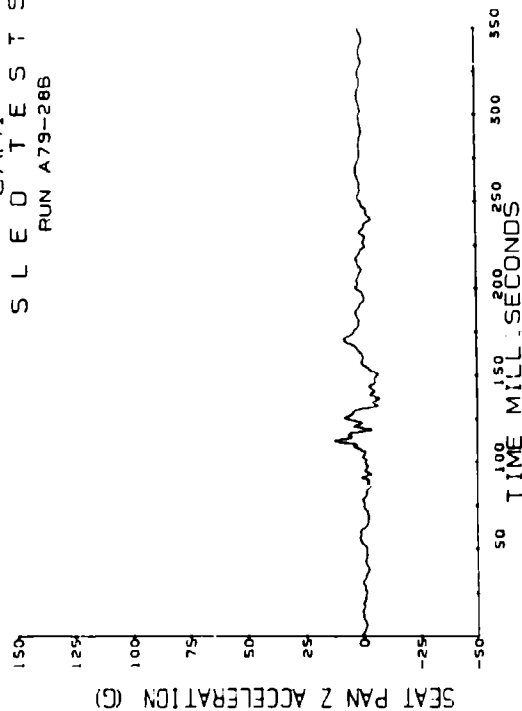
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S L E D T E S T S
RUN A79-28B



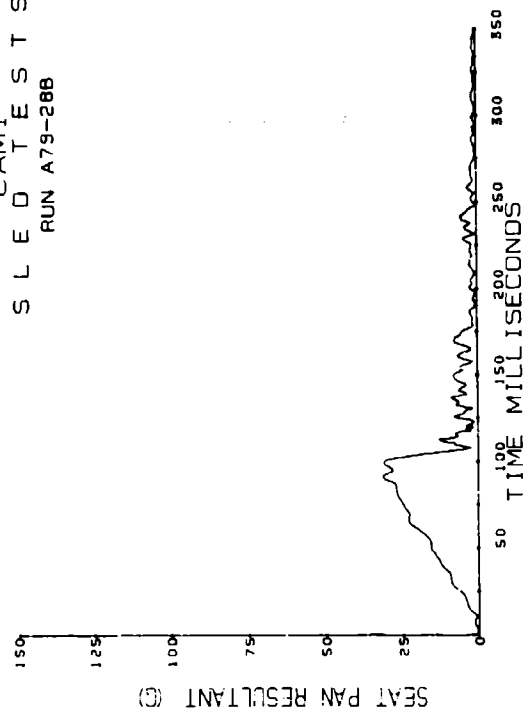
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S L E D T E S T S
RUN A79-28B



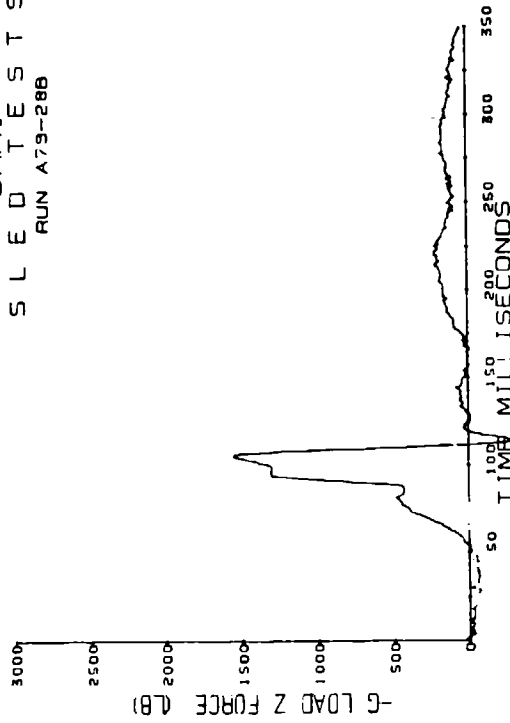
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S L E D T E S T S
RUN A79-28B



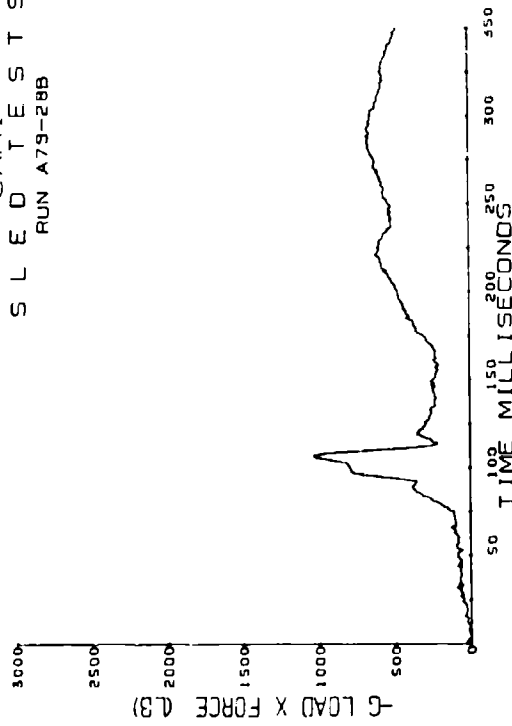
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S L E D T E S T S
RUN A79-28B



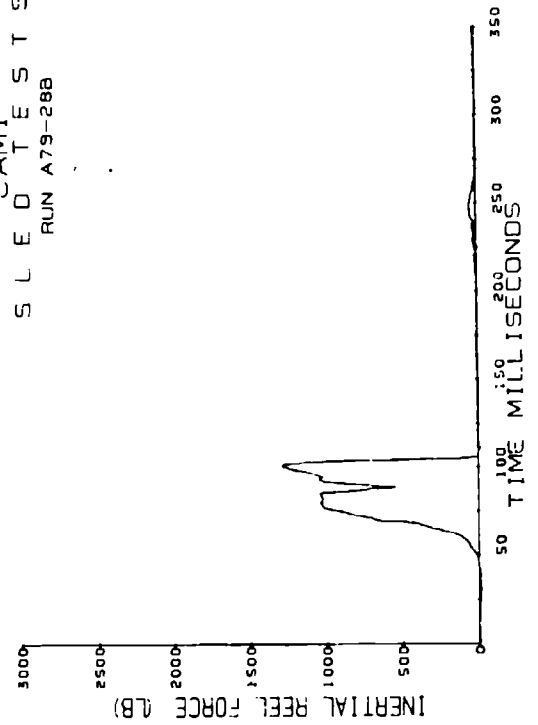
CAMI
S L E D T E S T S
RUN A79-288



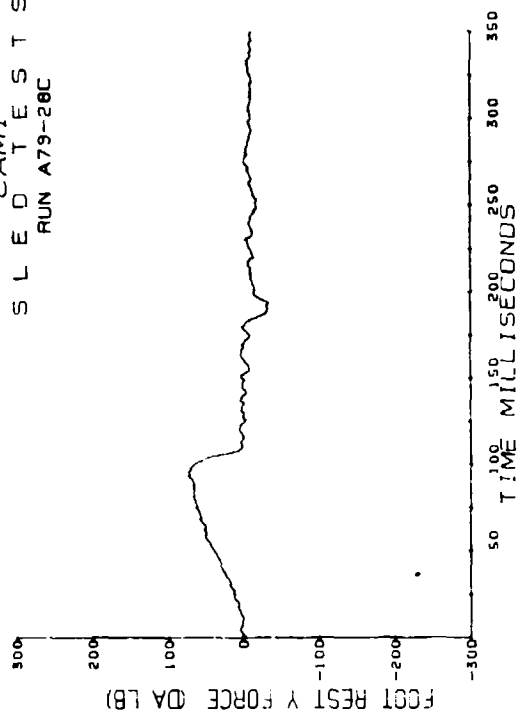
CAMI
S L E D T E S T S
RUN A79-288



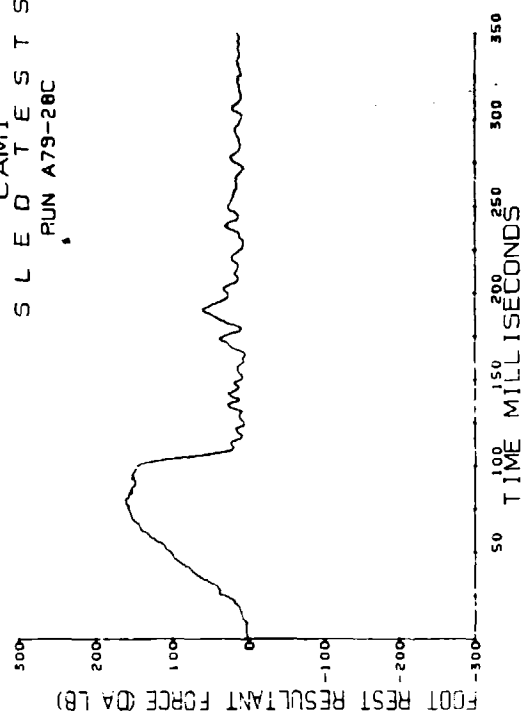
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S L E D T E S T S
RUN A79-288



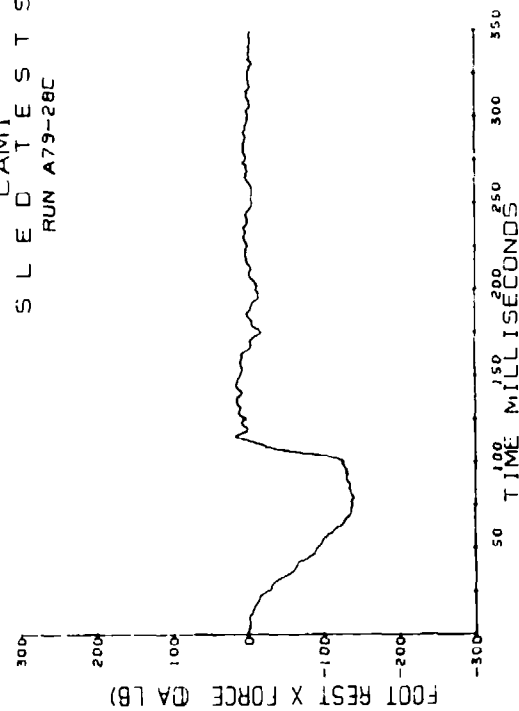
CAMI
S L E D T E S T S
RUN A79-28C



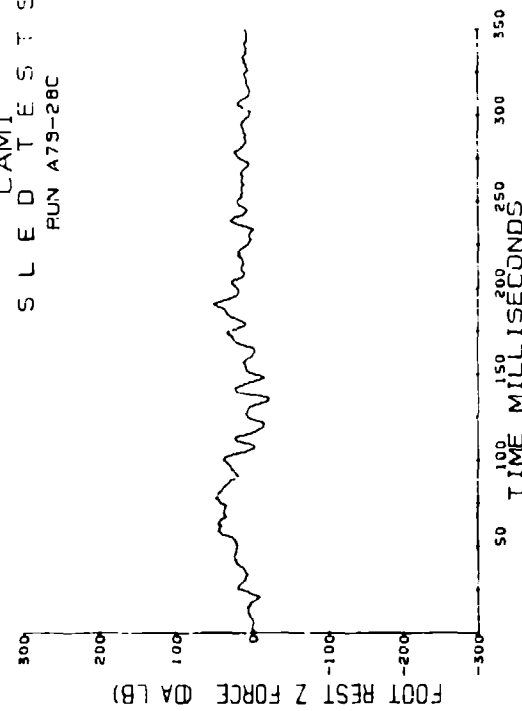
CAMI
S L E D T E S T S
RUN A79-28C

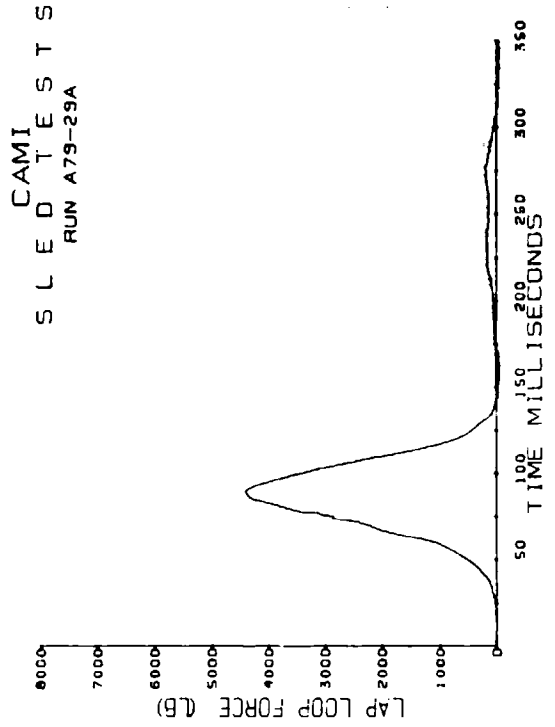
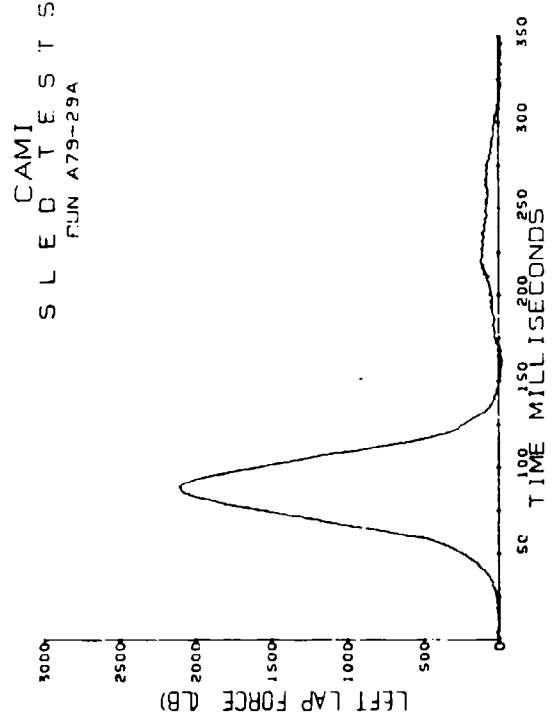
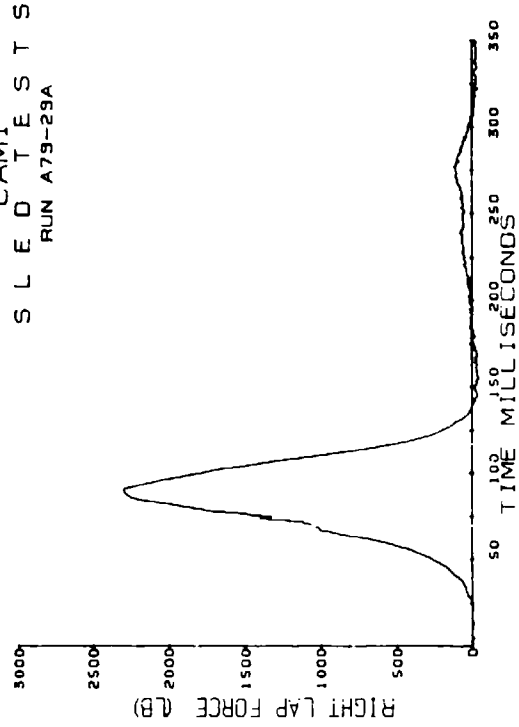
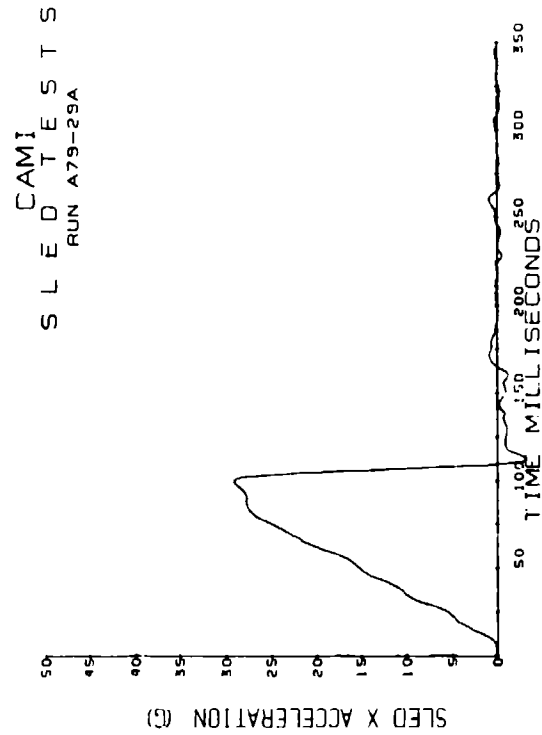


CAMI
S L E D T E S T S
RUN A79-28C

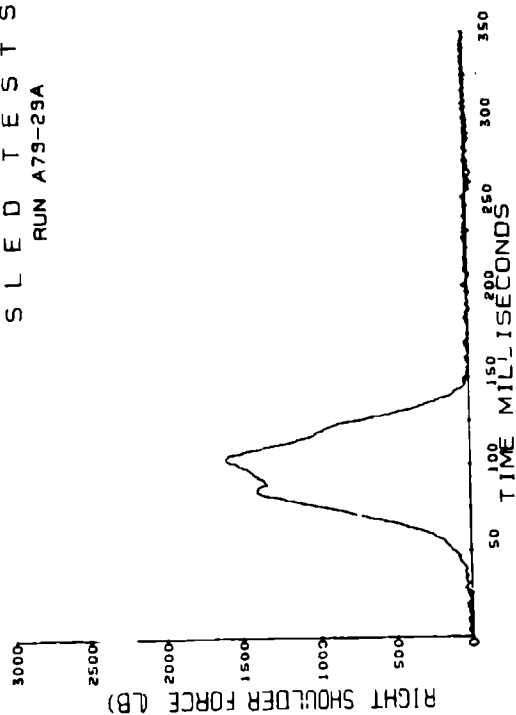


CAMI
S L E D T E S T S
RUN A79-28C

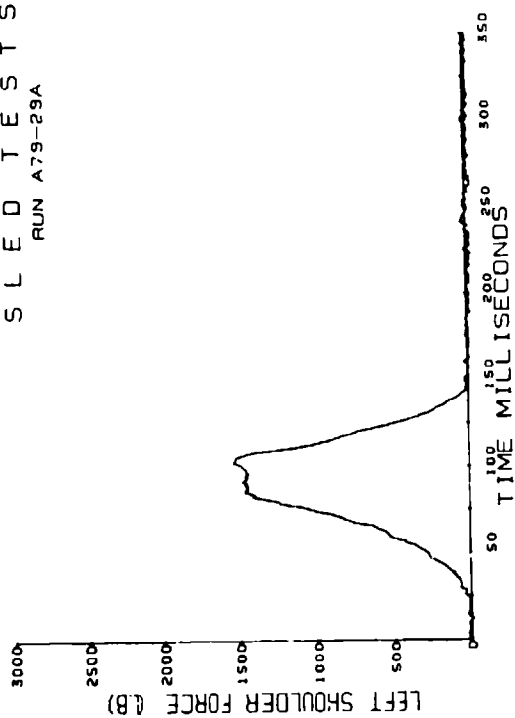




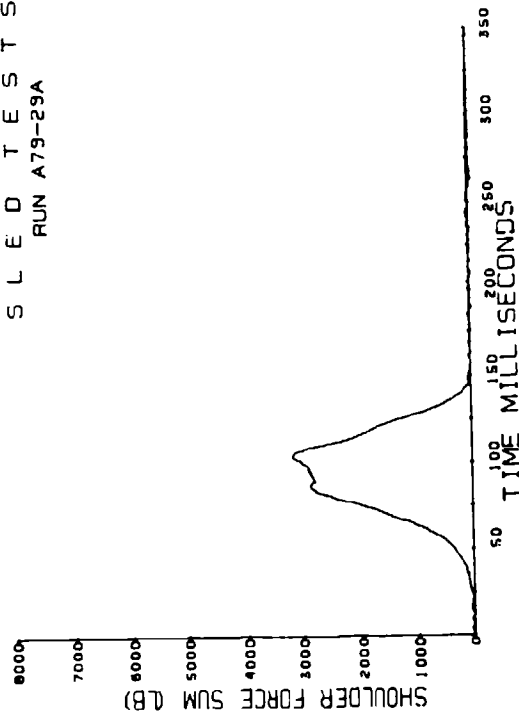
CAMI
S L E D T E S T S
RUN A79-29A



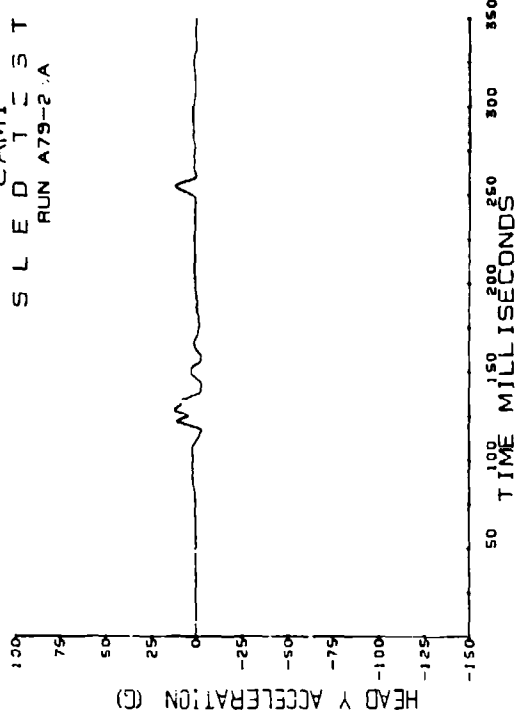
CAMI
S L E D T E S T S
RUN A79-29A



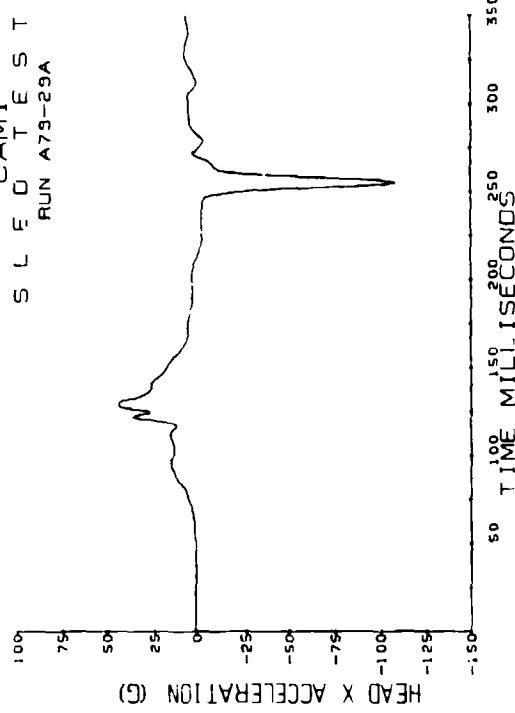
CAMI
S L E D T E S T S
RUN A79-29A



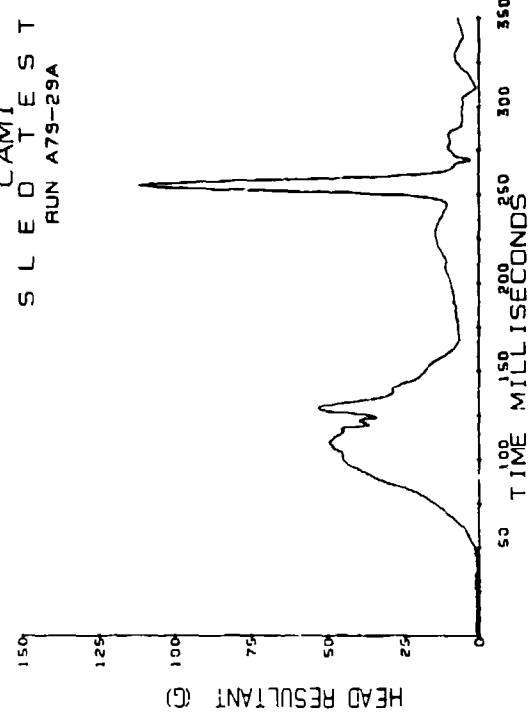
CAMI
S L E D T C S T S
RUN A79-29A



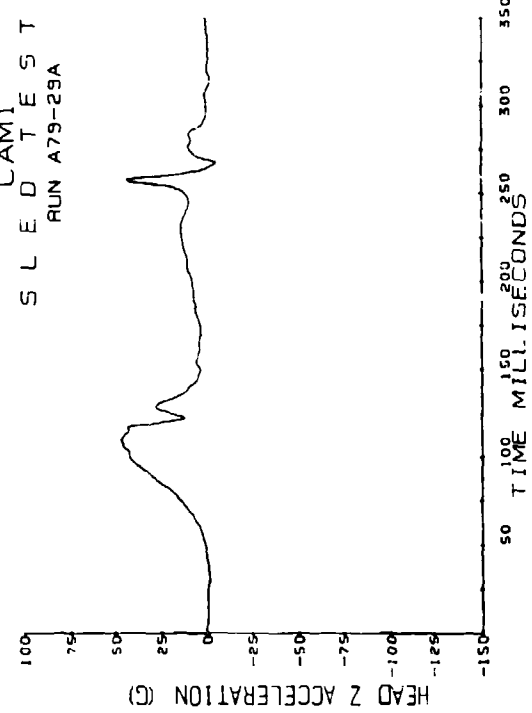
CAMI
S L E D T C S T S
RUN A79-29A

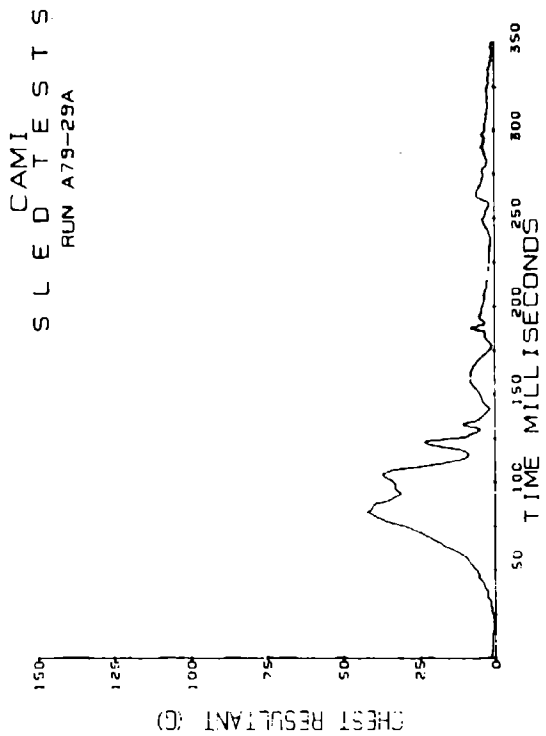
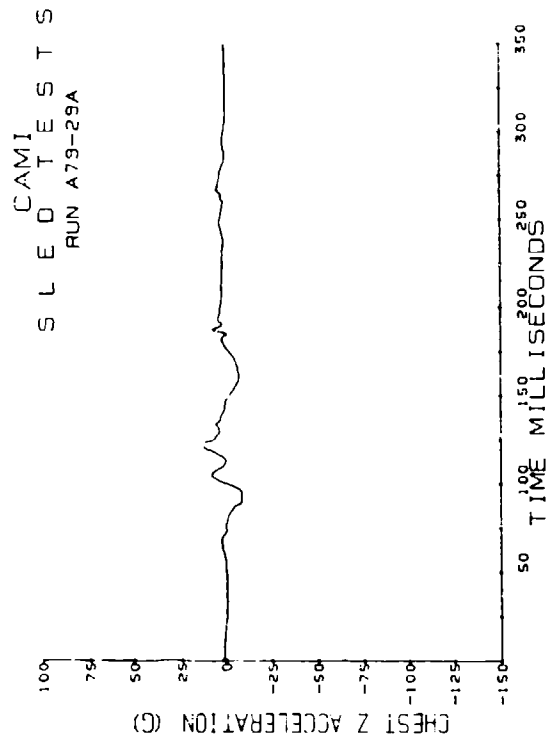
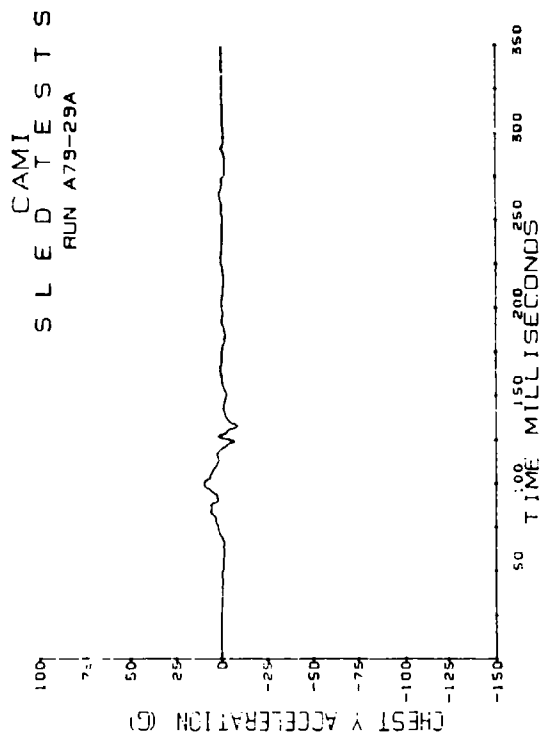
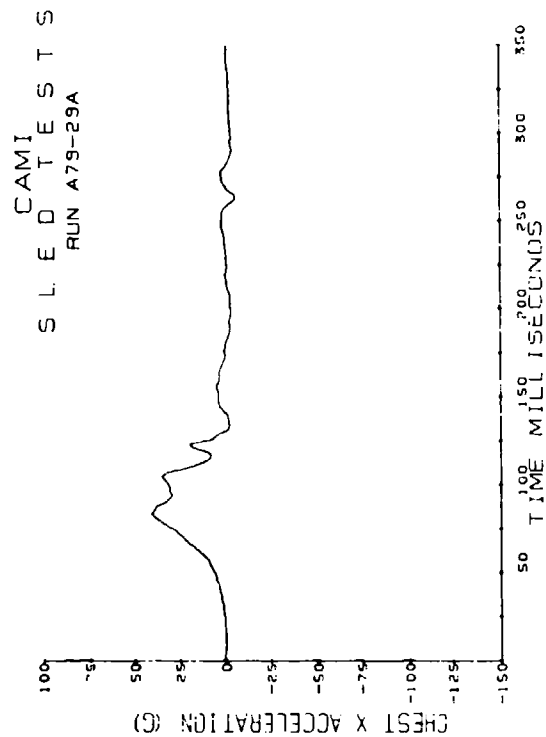


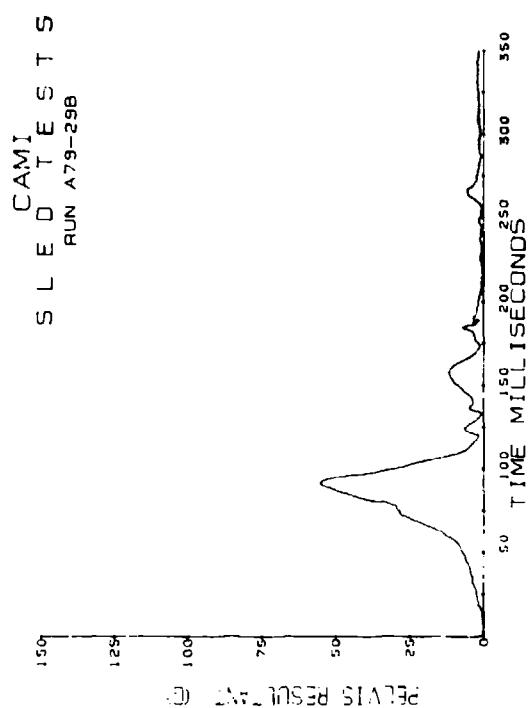
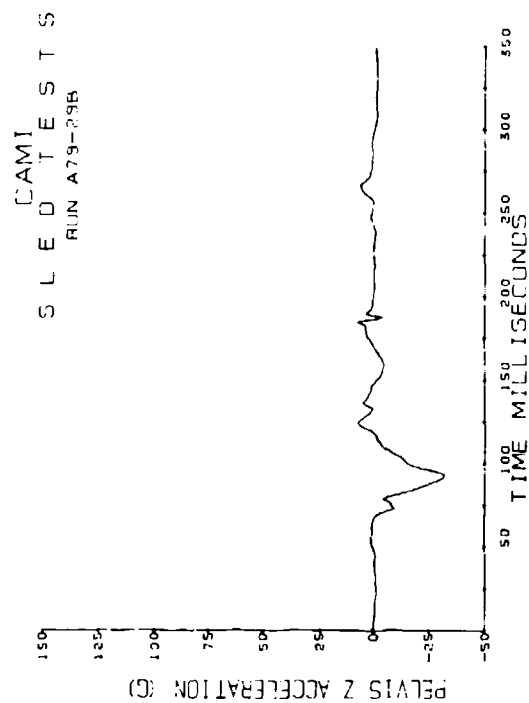
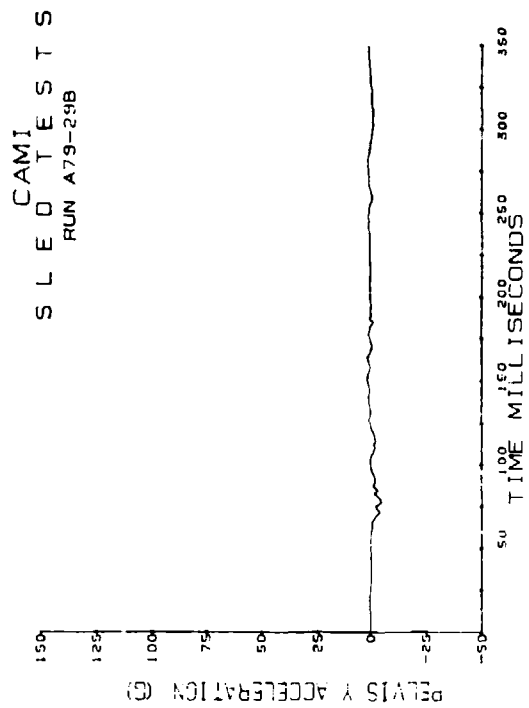
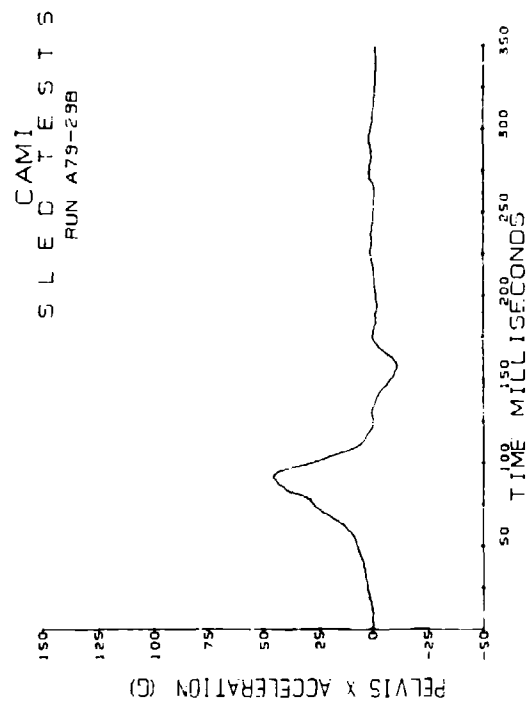
CAMI
S L E D T C S T S
RUN A79-29A



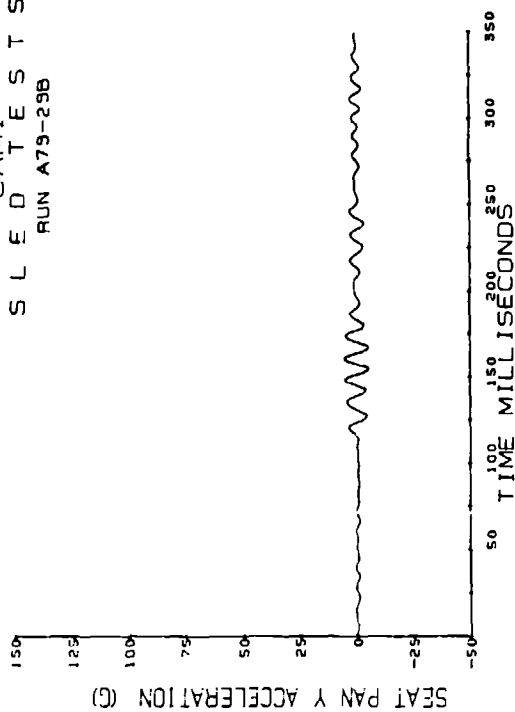
CAMI
S L E D T C S T S
RUN A79-29A



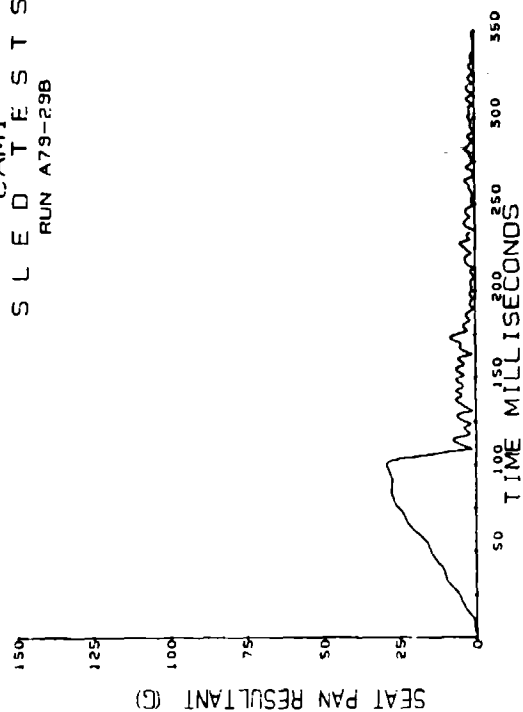




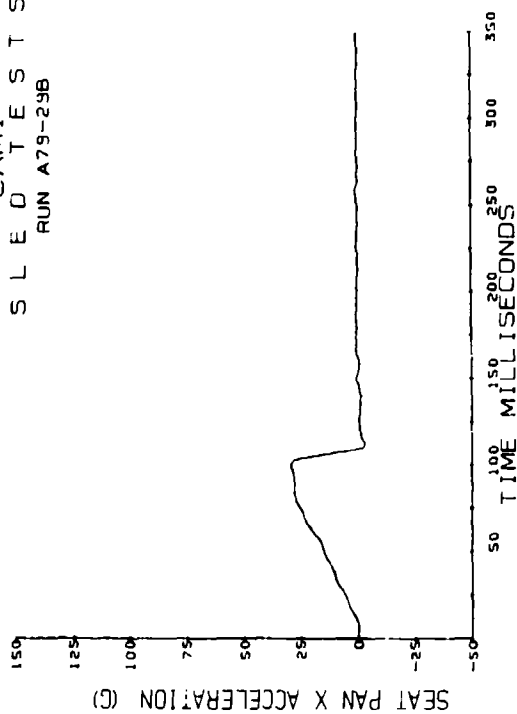
CAMI
S L E D T E S T S
RUN A79-29B



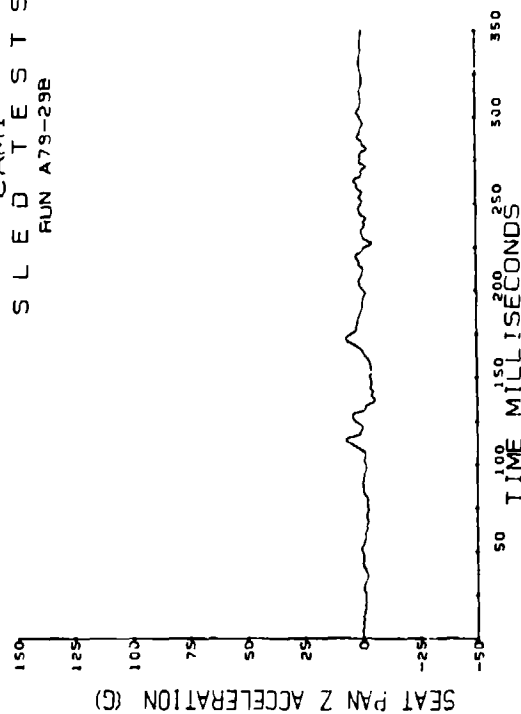
CAMI
S L E D T E S T S
RUN A79-29B



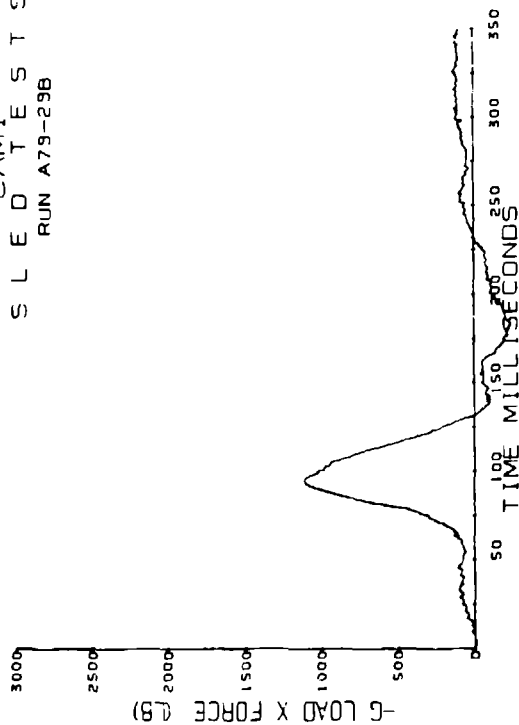
CAMI
S L E D T E S T S
RUN A79-29B



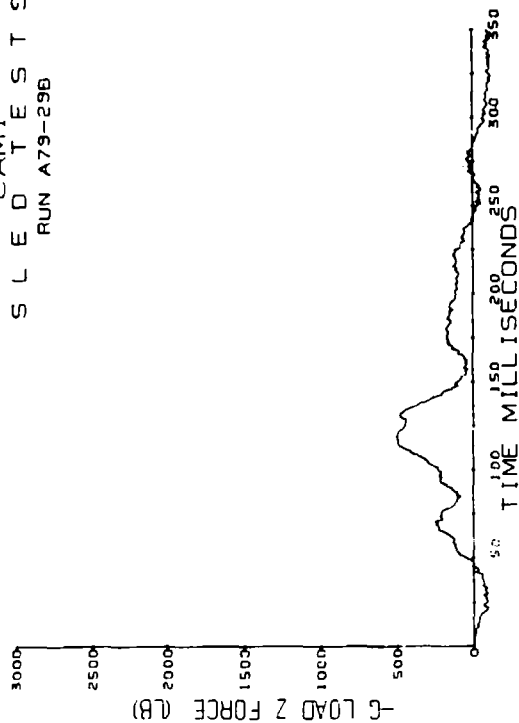
CAMI
S L E D T E S T S
RUN A79-29B



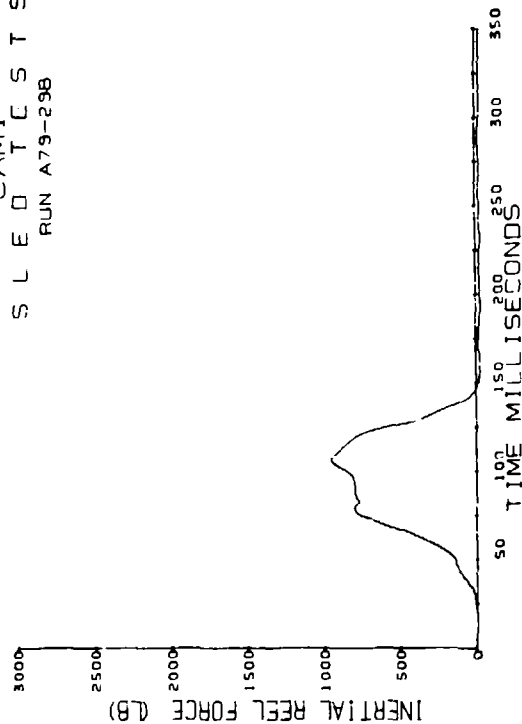
CAMI
S L E D T E S T S
RUN A79-29B

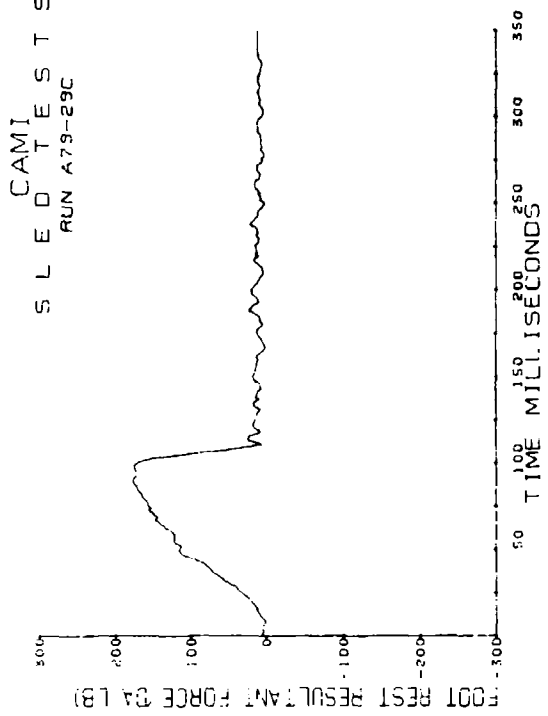
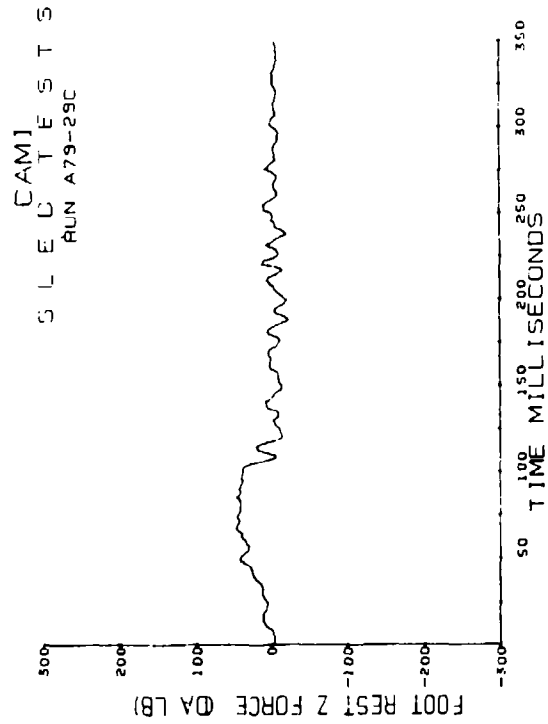
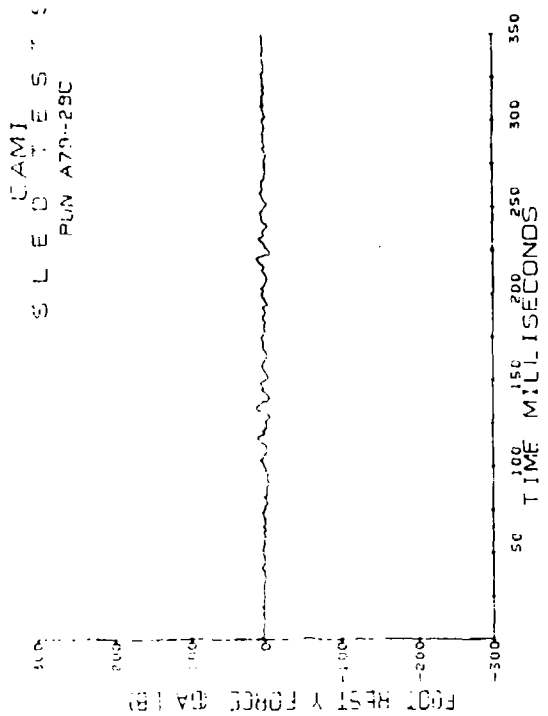
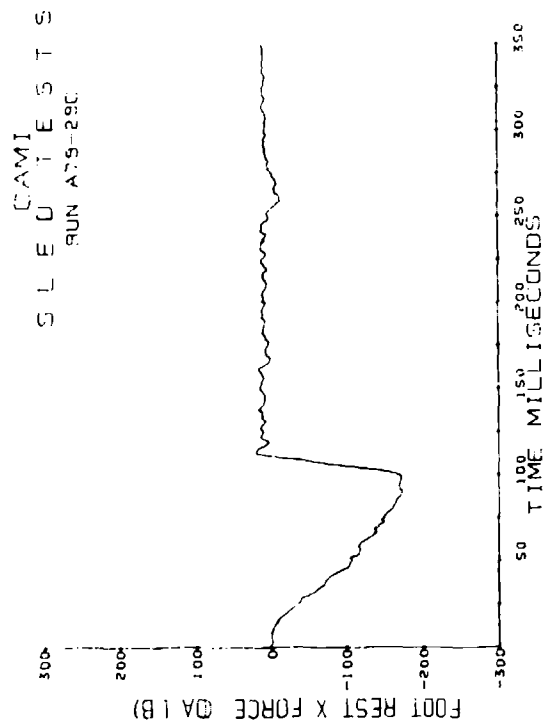


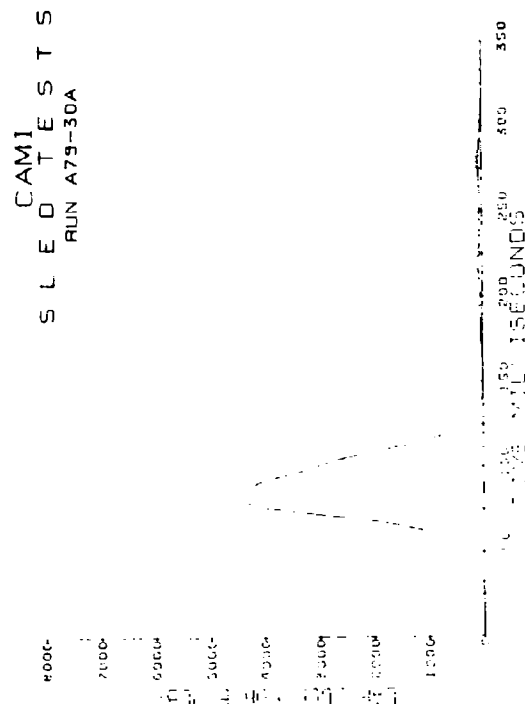
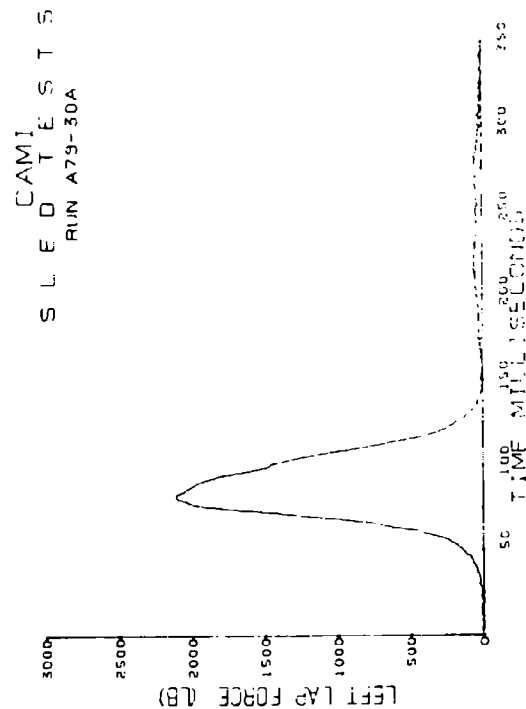
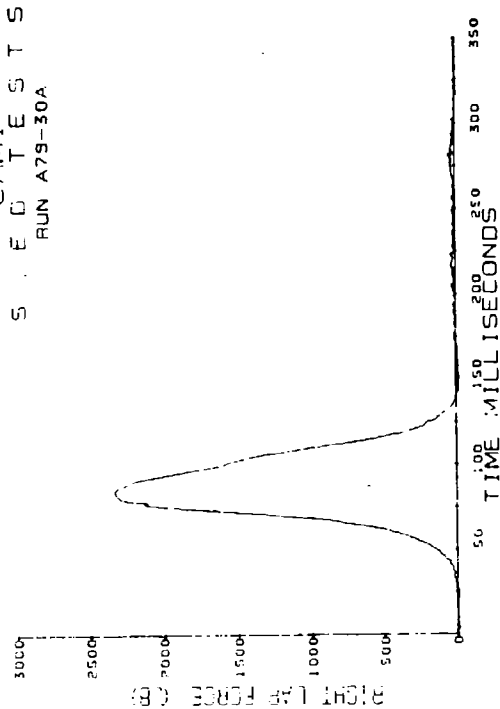
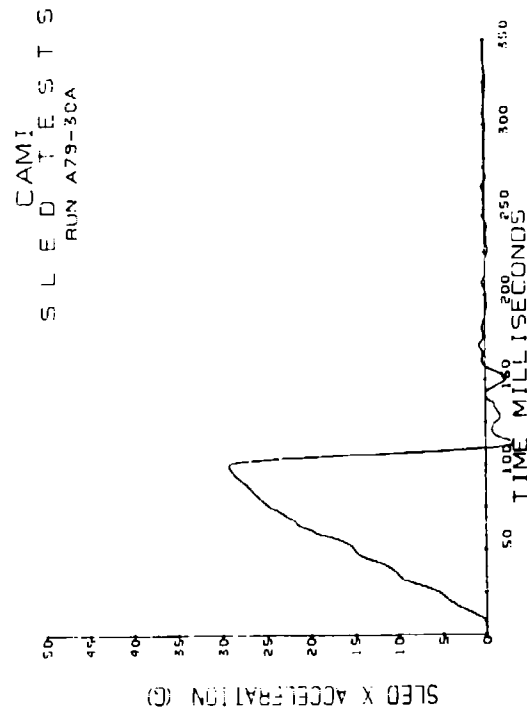
CAMI
S L E D T E S T S
RUN A79-29B



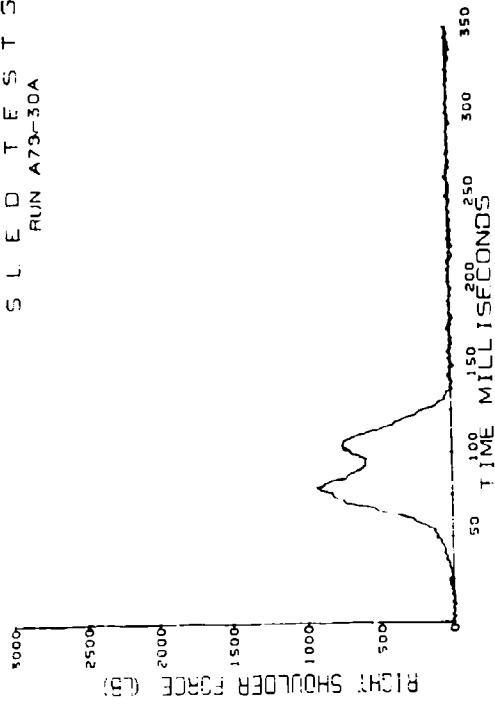
CAMI
S L E D T E S T S
RUN A79-29B



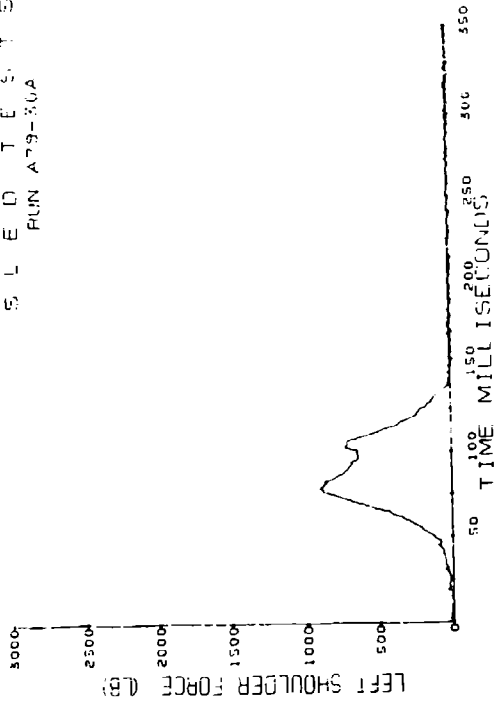




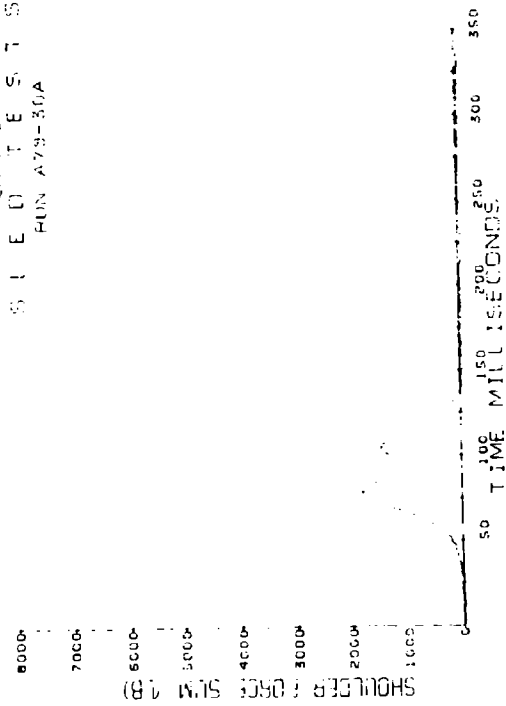
CAMI
S L E D T E S T S
RUN A79-30A

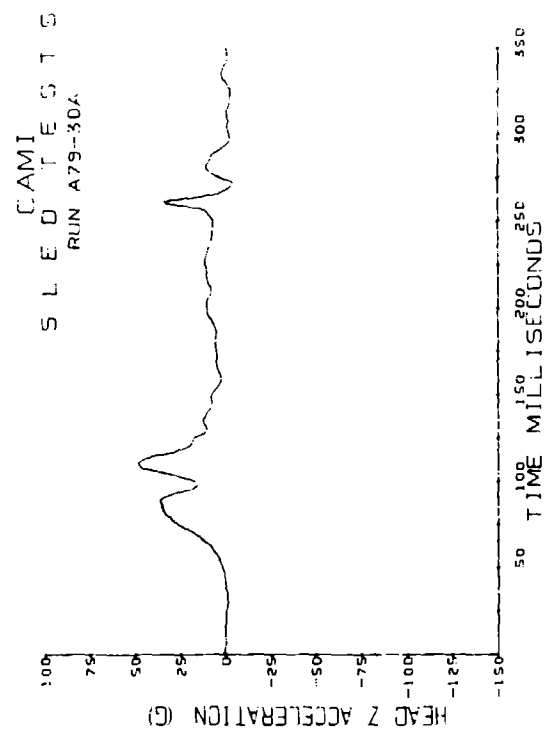
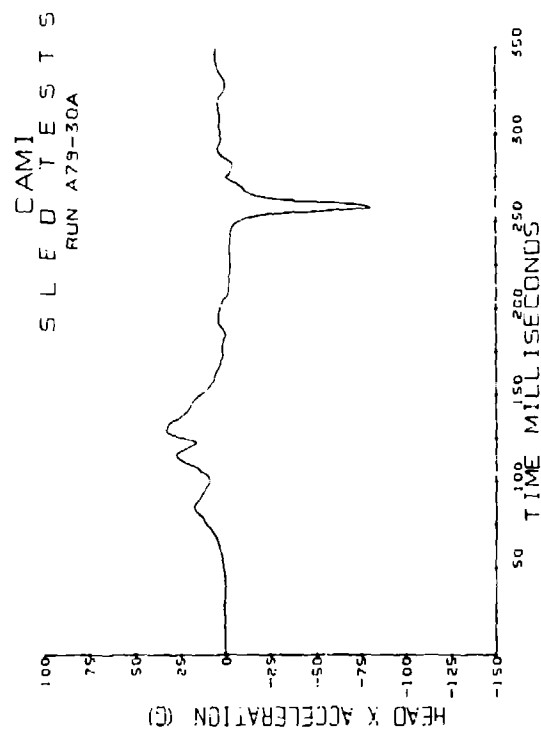
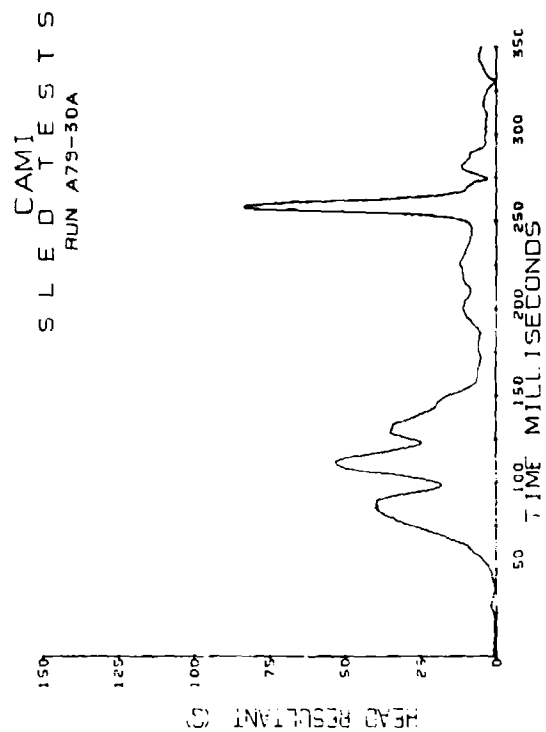
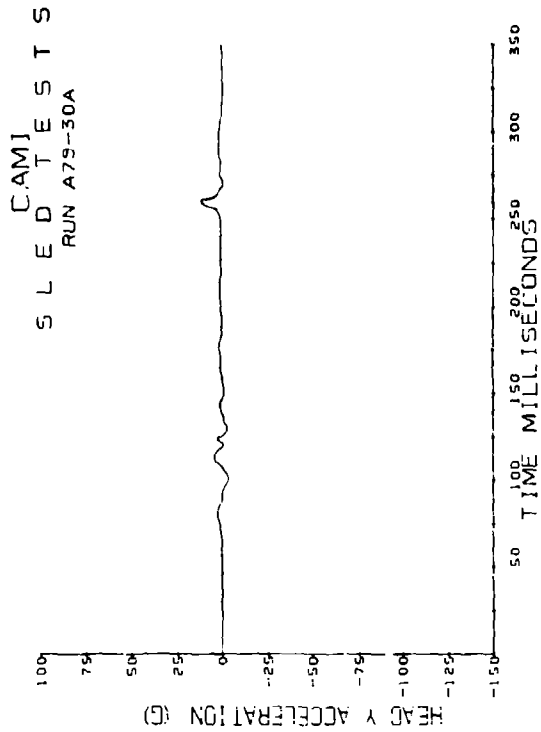


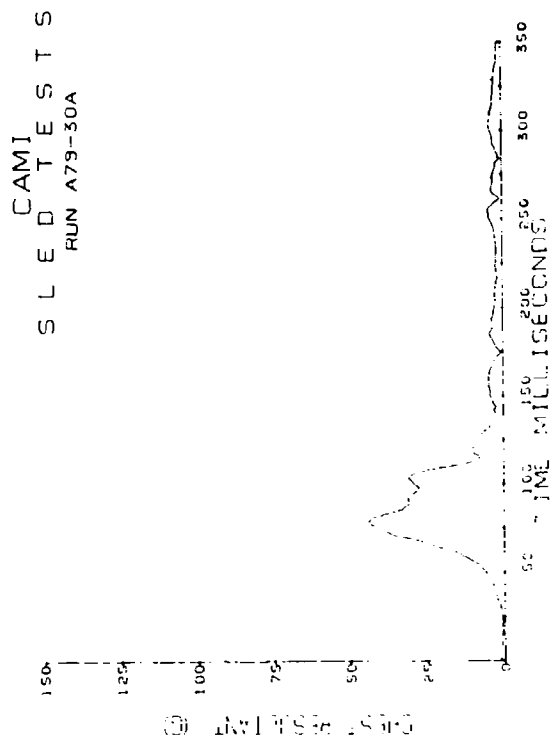
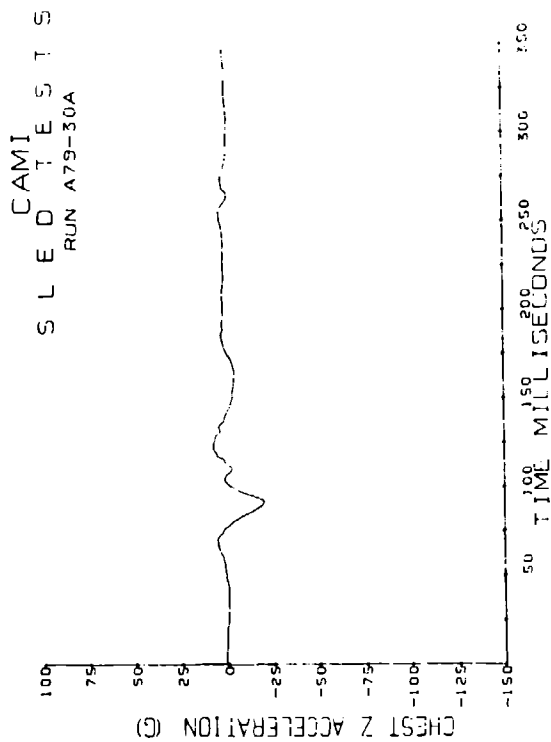
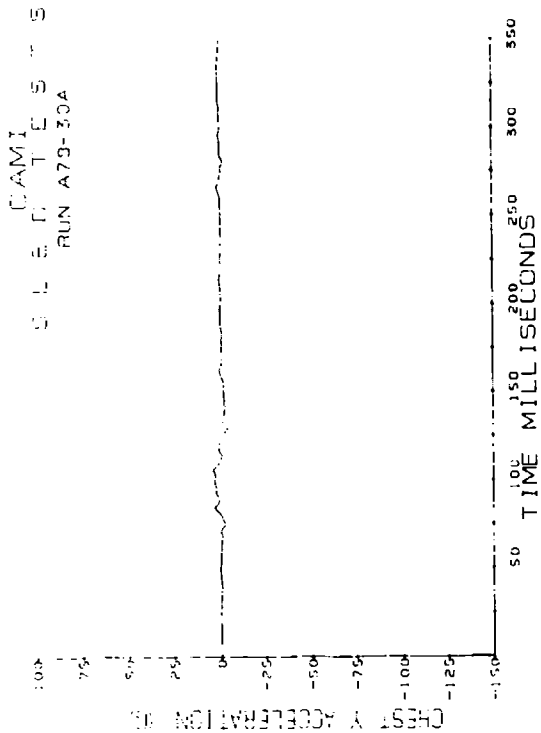
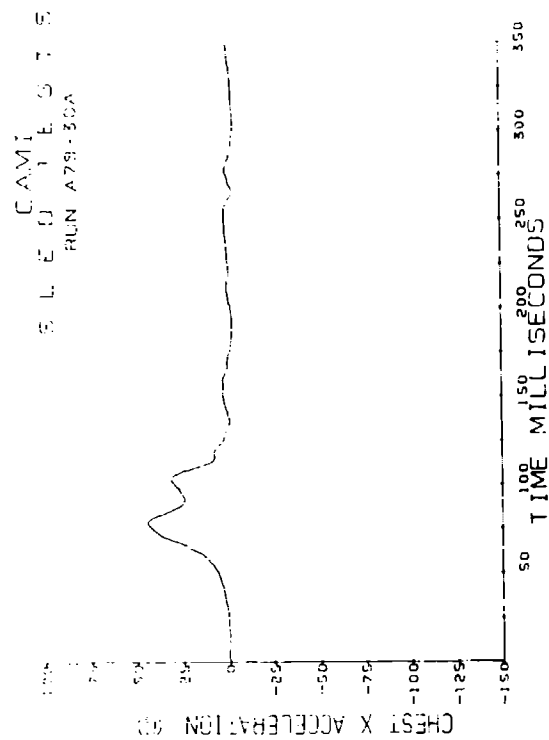
CAMI
S L E D T E S T S
RUN A79-30A



CAMI
S L E D T E S T S
RUN A79-30A

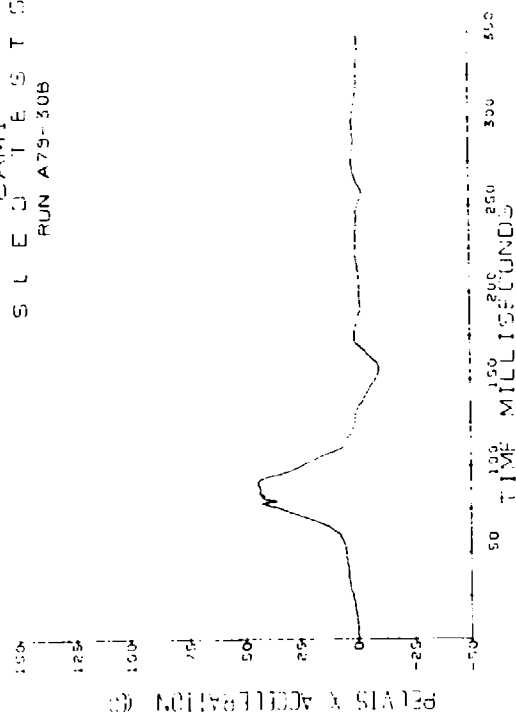
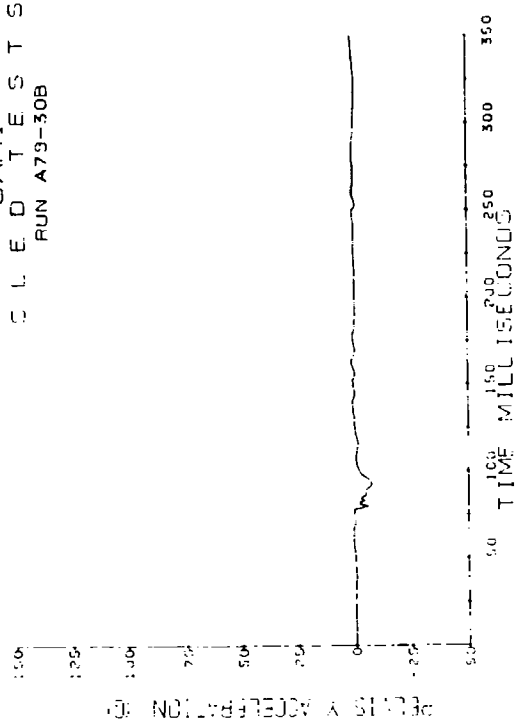






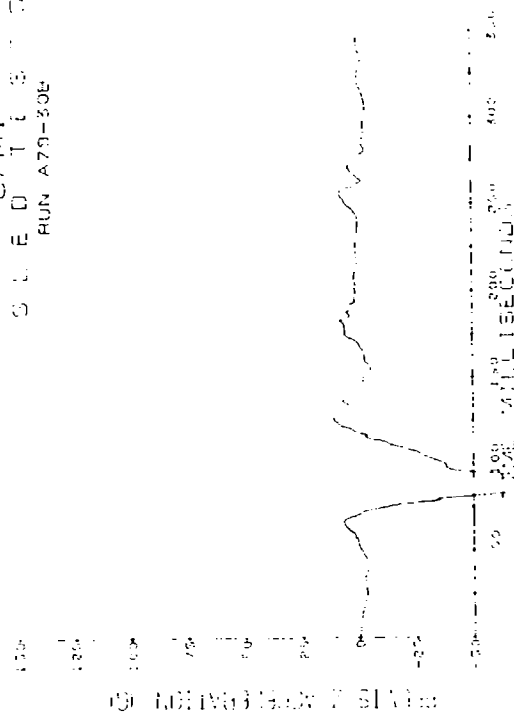
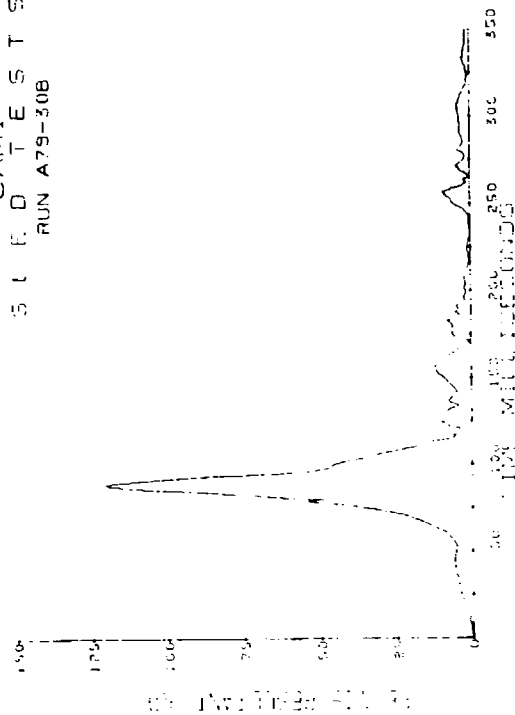
CAMI
S L E D T E S T S
RUN A79-30B

CAMI
S L E D T E S T S
RUN A79-30B

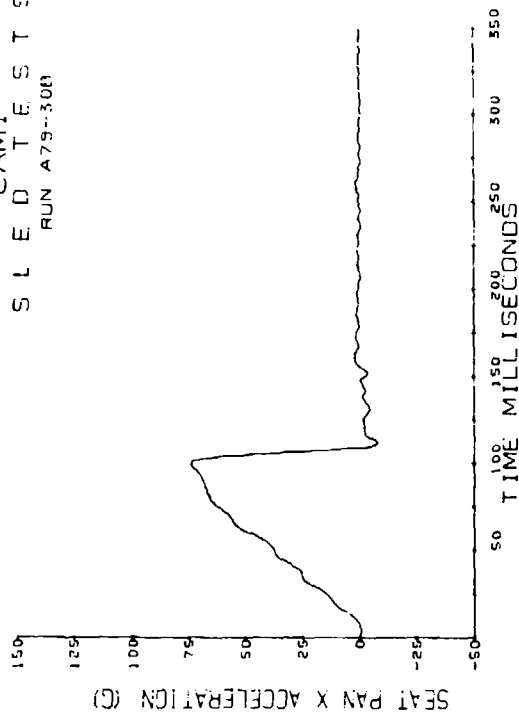


CAMI
S L E D T E S T S
RUN A79-30B

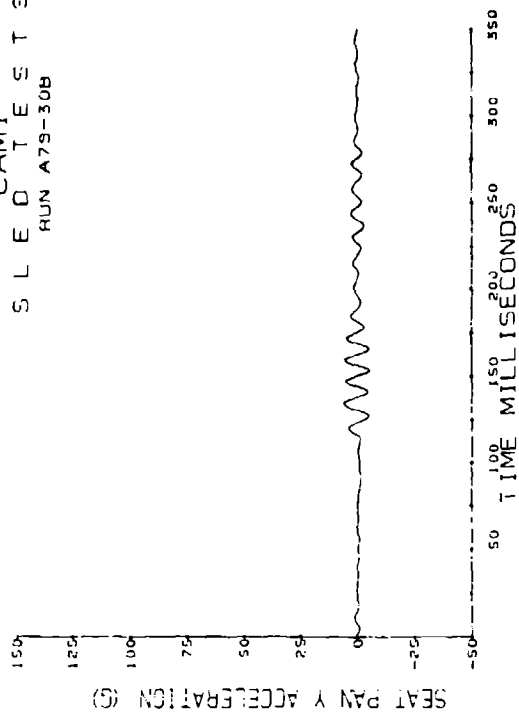
CAMI
S L E D T E S T S
RUN A79-30B



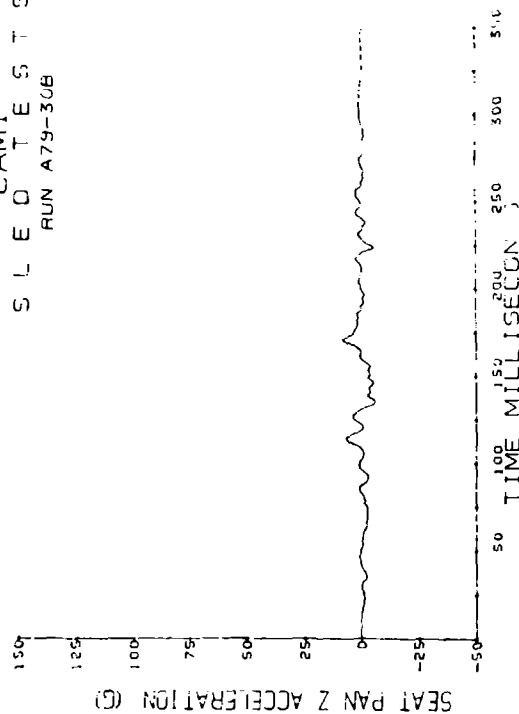
CAMI
S L E D T E S T S
RUN A79-308



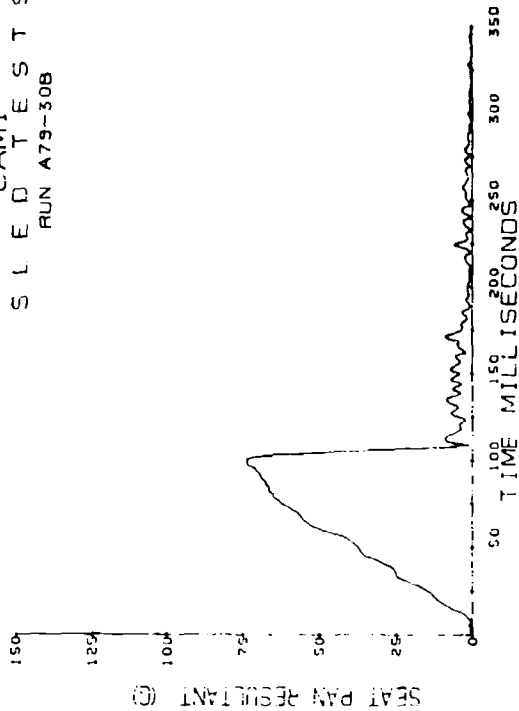
CAMI
S L E D T E S T S
RUN A79-308



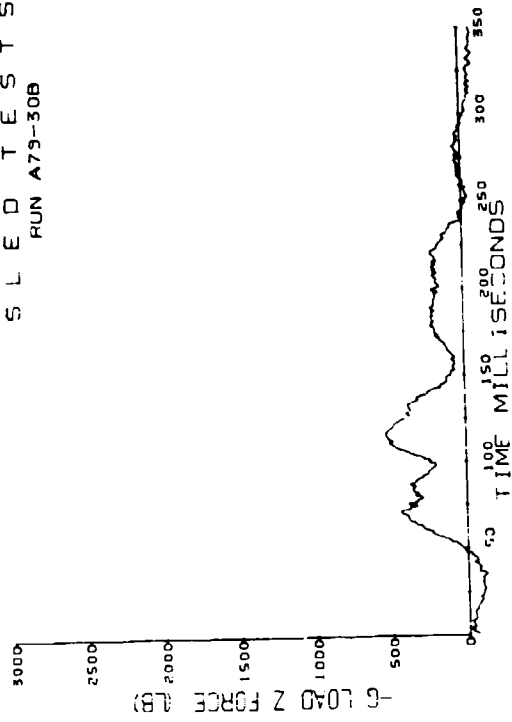
CAMI
S L E D T E S T S
RUN A79-308



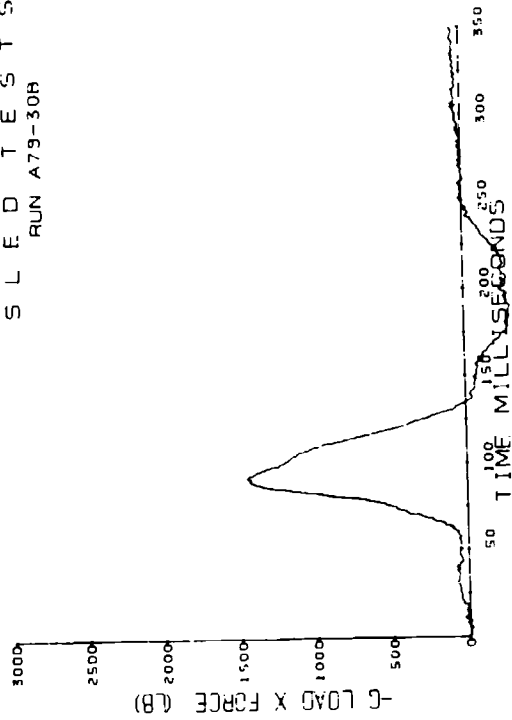
CAMI
S L E D T E S T S
RUN A79-308



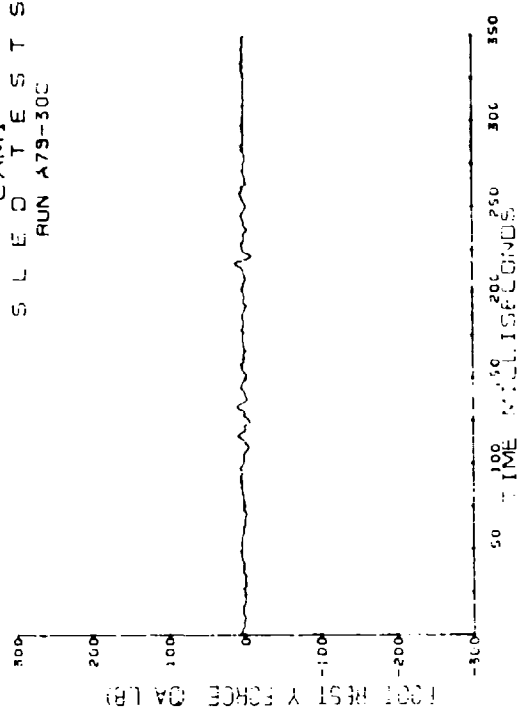
CAM1
S L E D T E S T S
RUN A79-30B



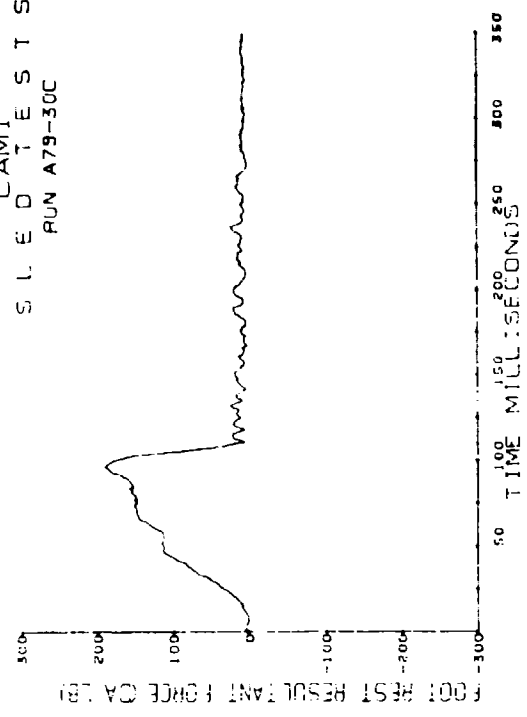
CAM1
S L E D T E S T S
RUN A79-30B



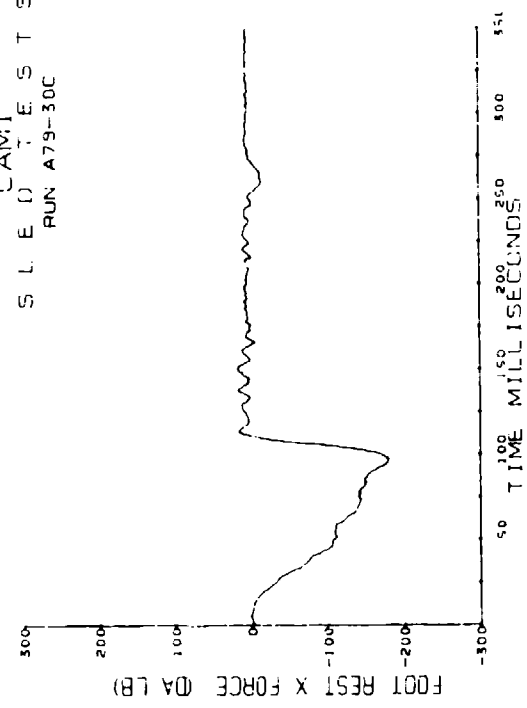
CAMI
S L E D T E S T S
RUN A79-30C



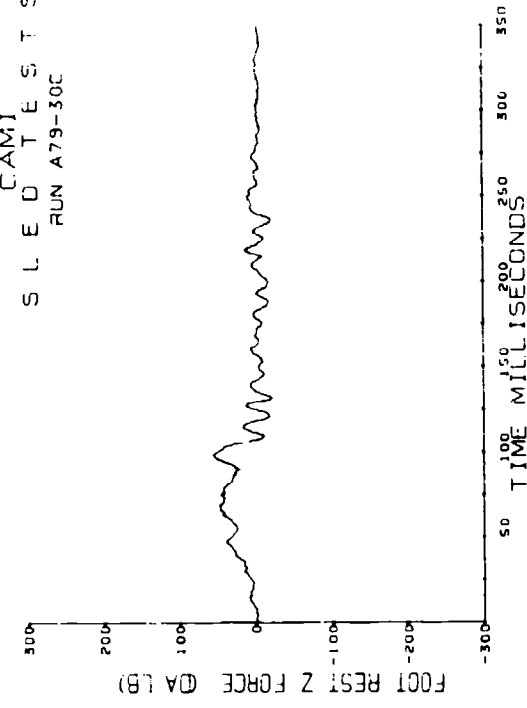
CAMI
S L E D T E S T S
RUN A79-30C

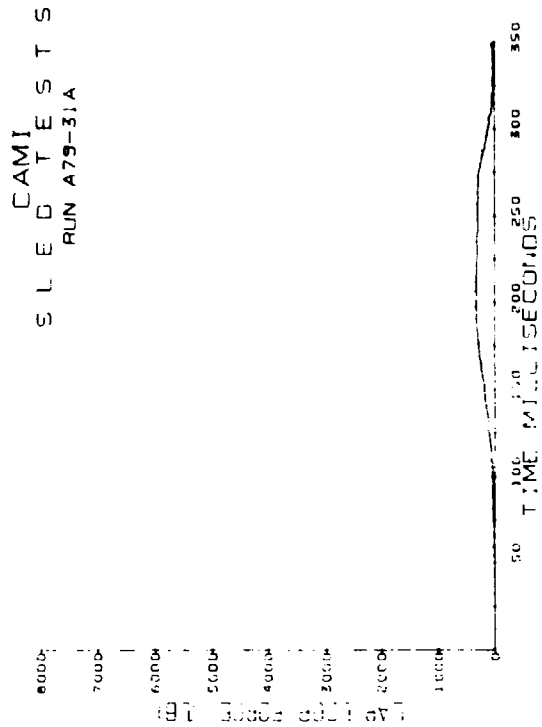
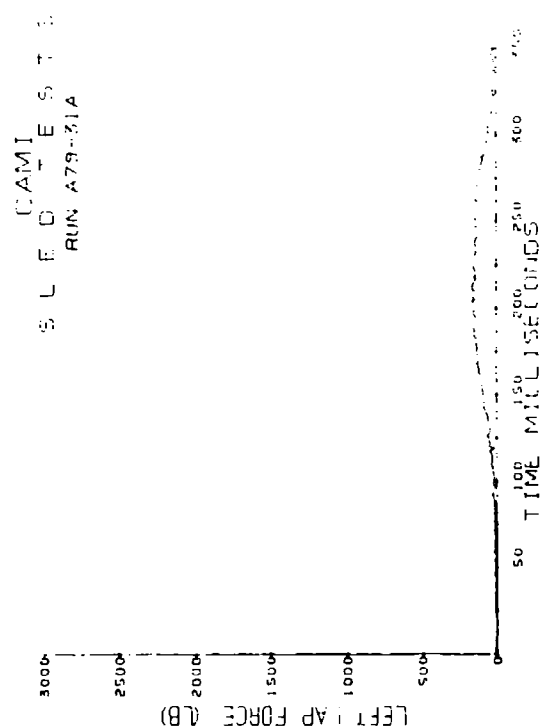
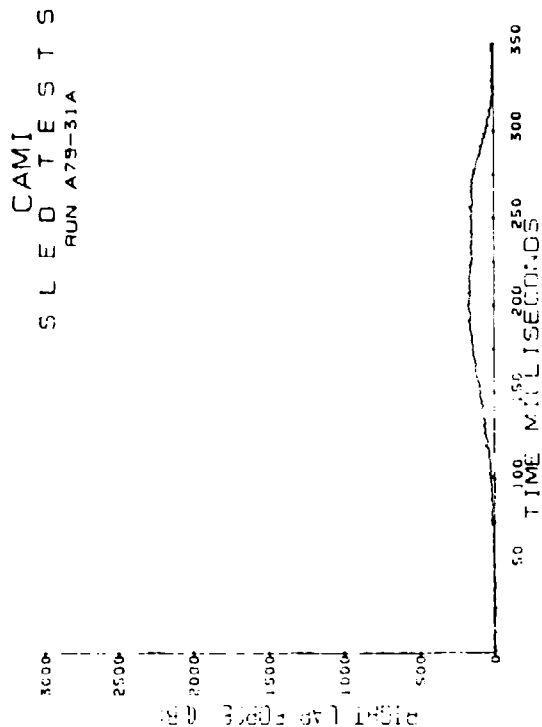
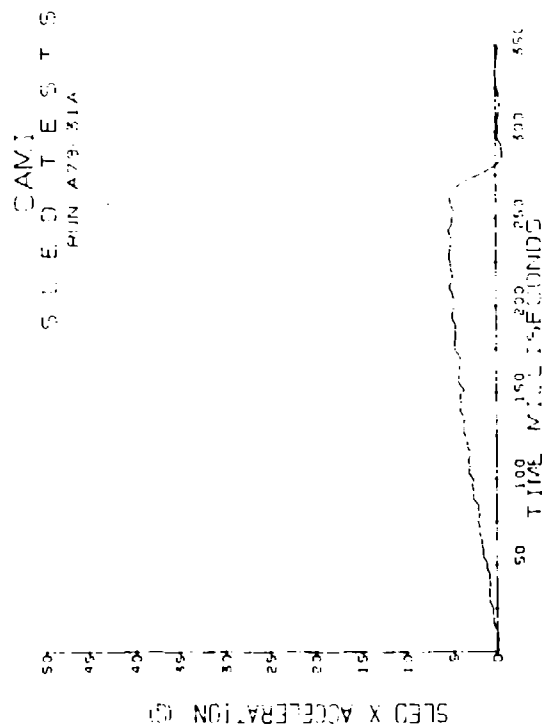


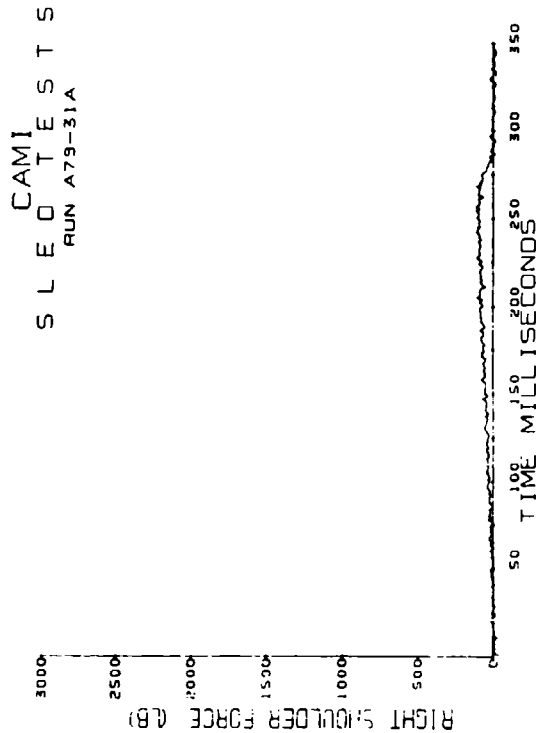
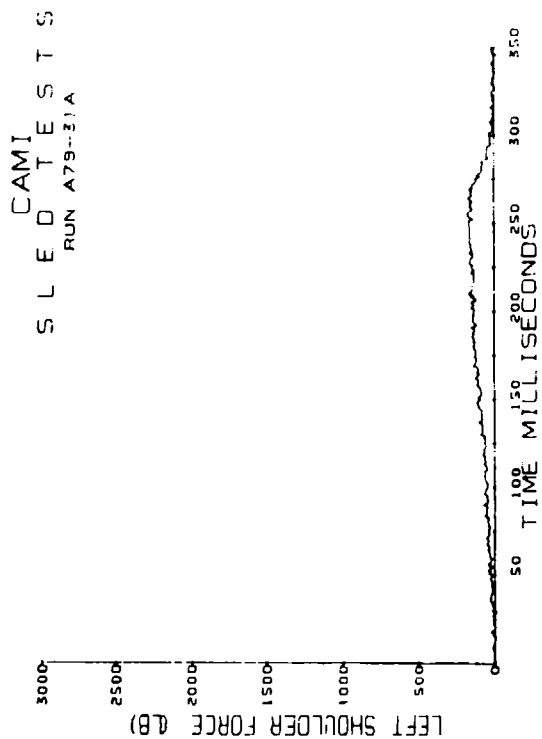
CAMI
S L E D T E S T S
RUN A79-30C



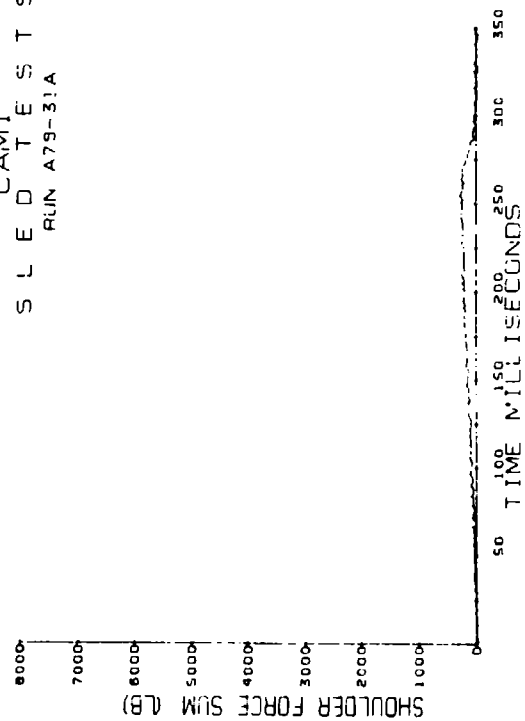
CAMI
S L E D T E S T S
RUN A79-30C

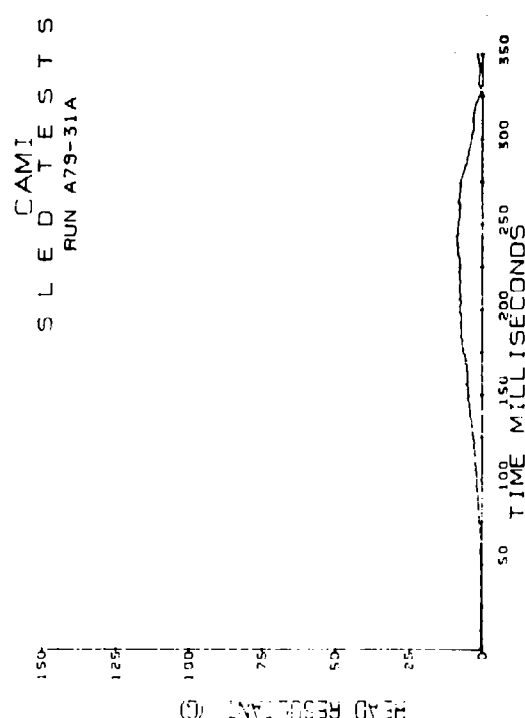
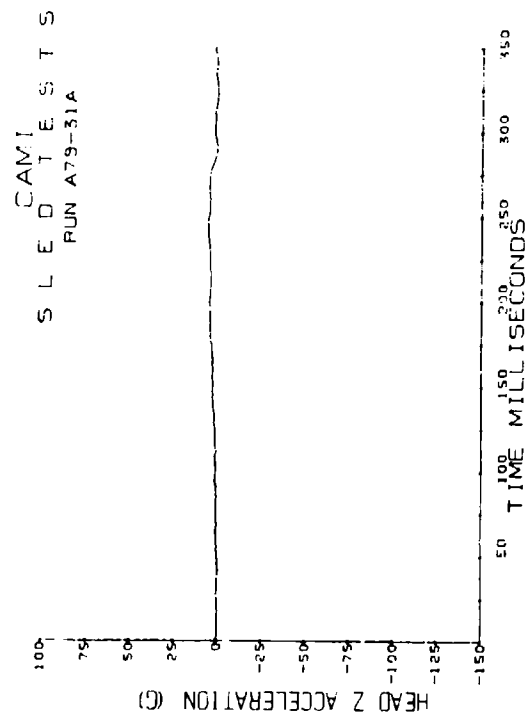
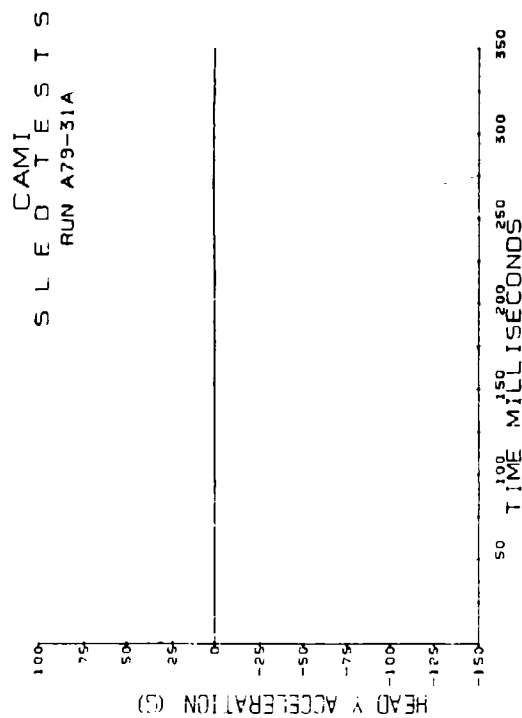
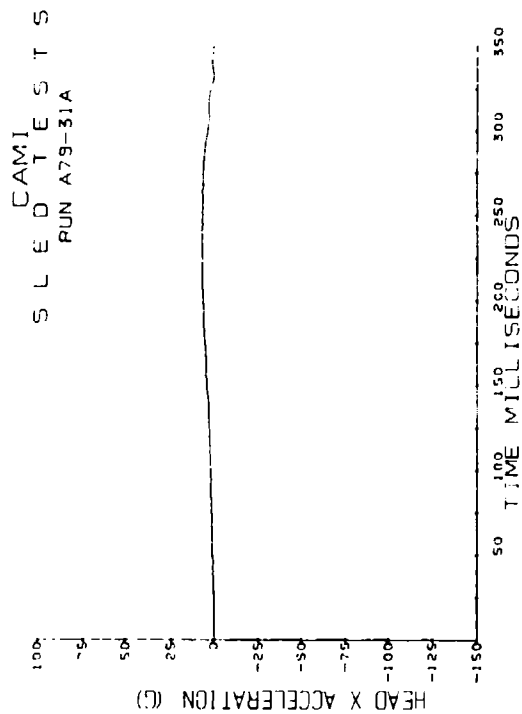


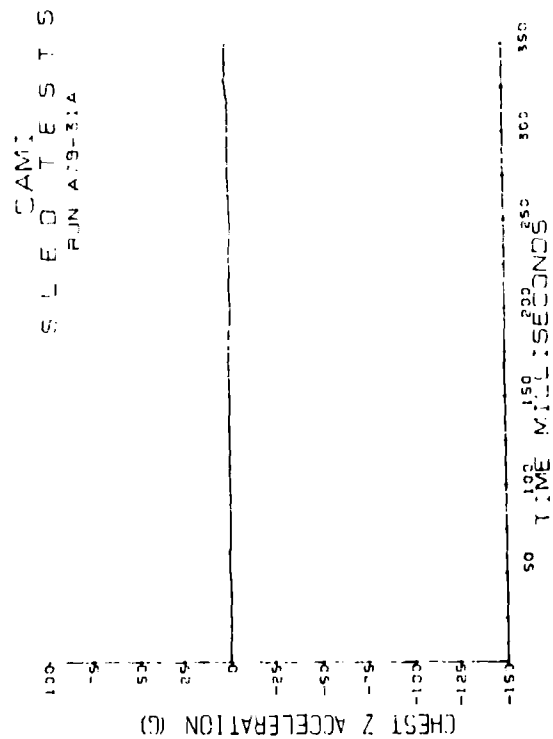
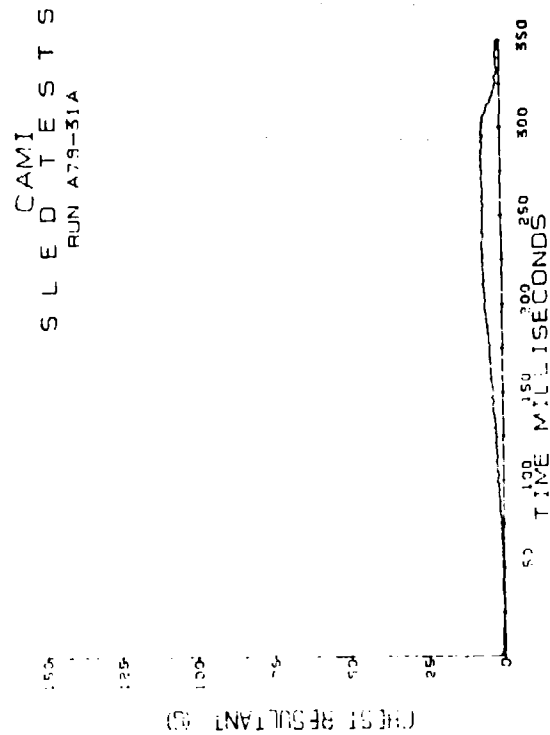
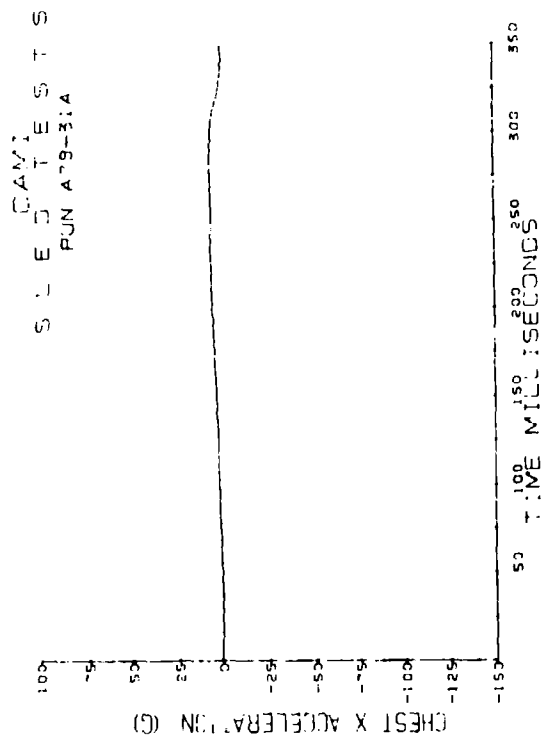
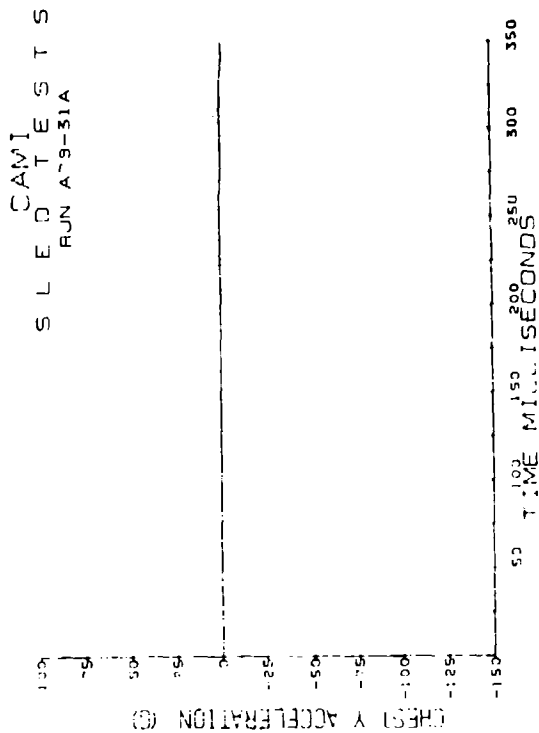




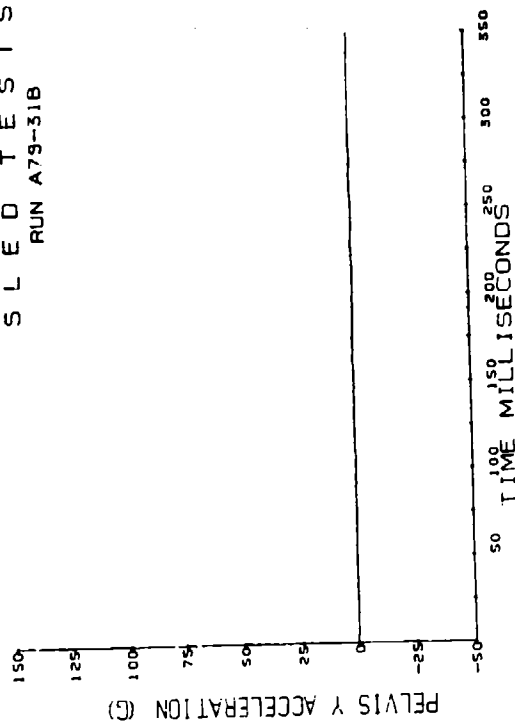
CAMI
S L E D T E S T S
RUN A79-31A



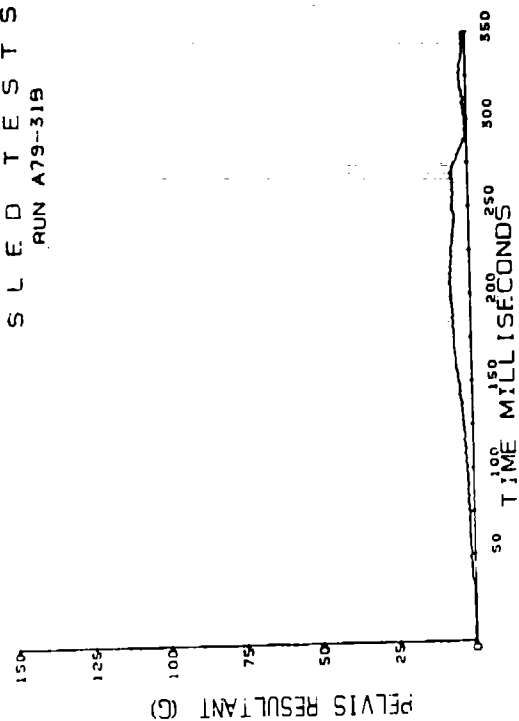




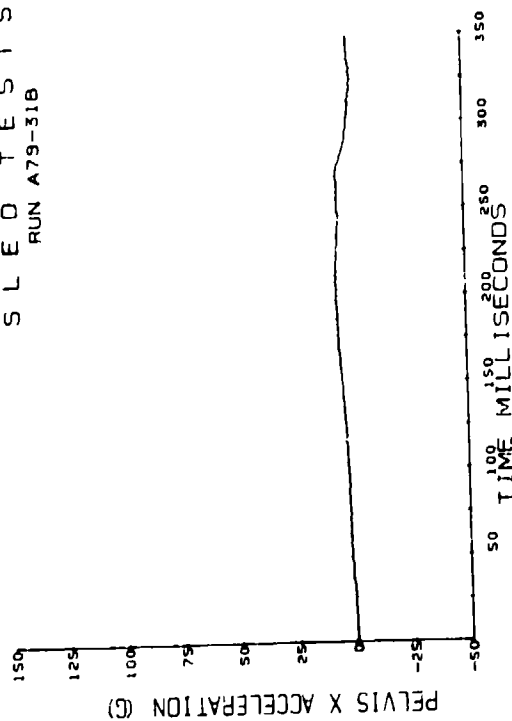
CAMI
S L E D T E S T S
RUN A79-31B



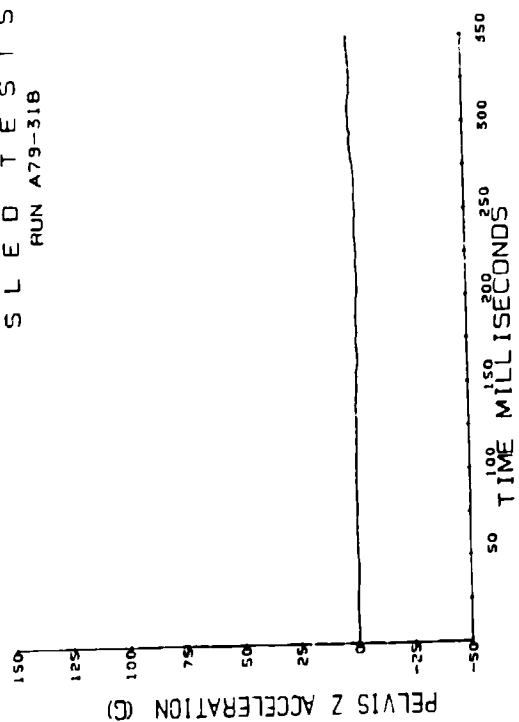
CAMI
S L E D T E S T S
RUN A79-31B



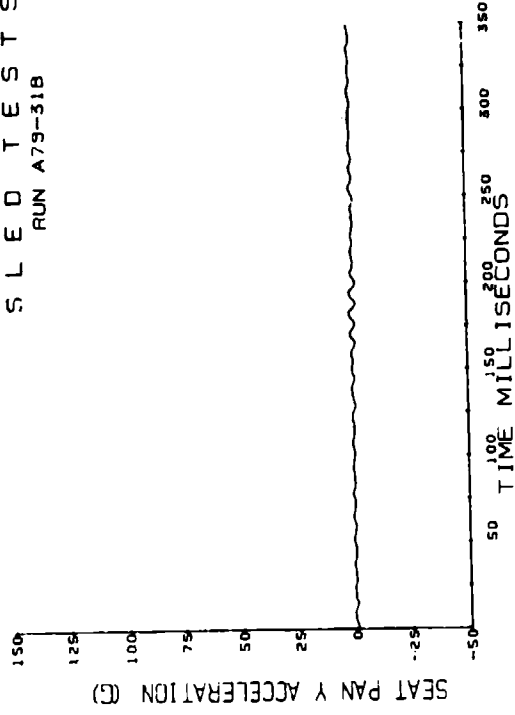
CAMI
S L E D T E S T S
RUN A79-31B



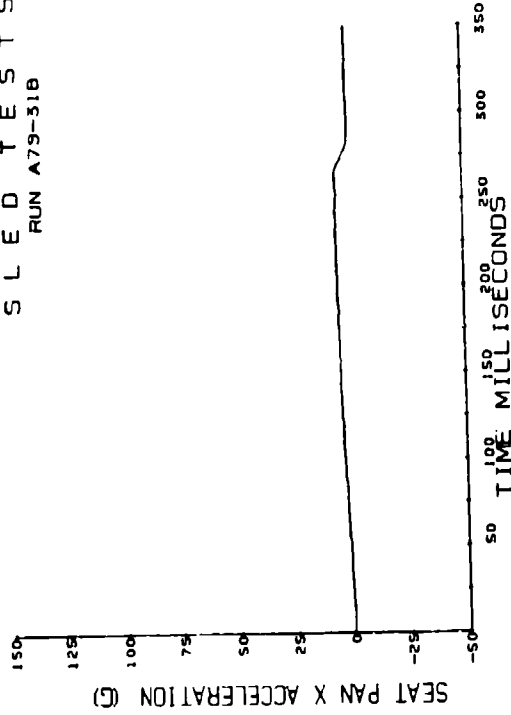
CAMI
S L E D T E S T S
RUN A79-31B



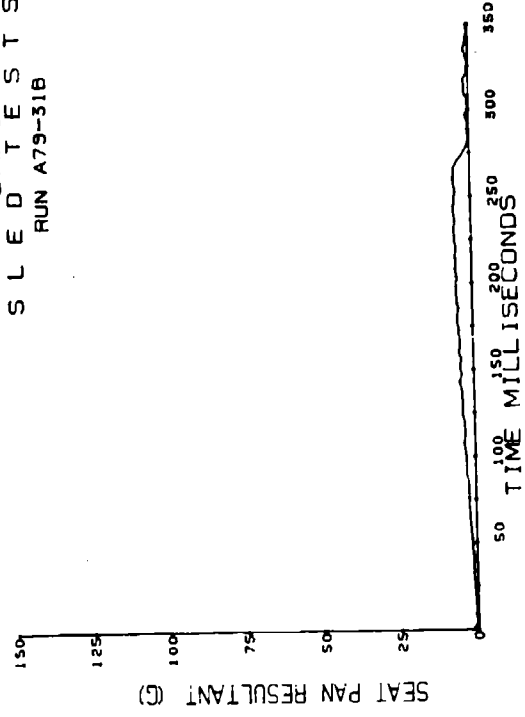
CAMI
S L E D T E S T S
RUN A79-31B



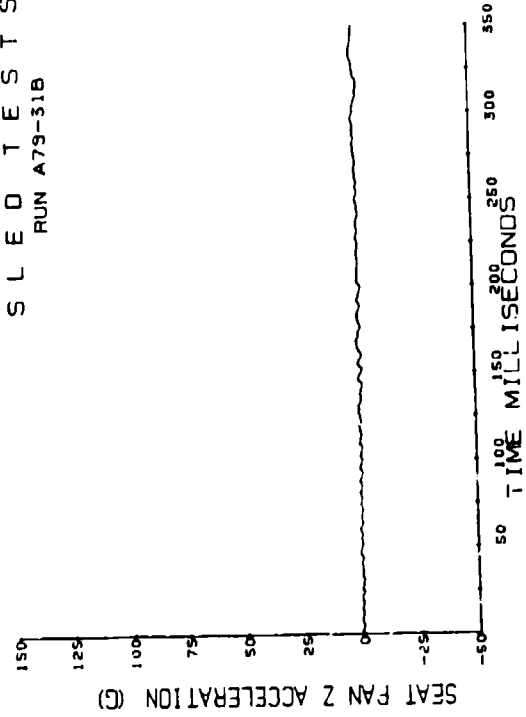
CAMI
S L E D T E S T S
RUN A79-31B



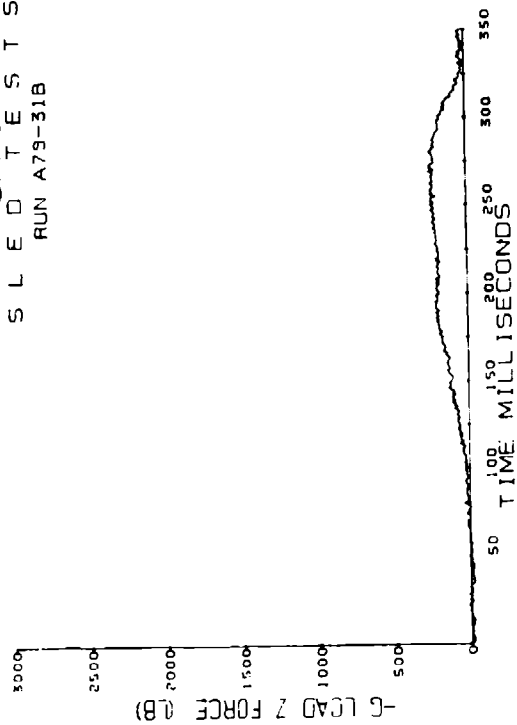
CAMI
S L E D T E S T S
RUN A79-31B



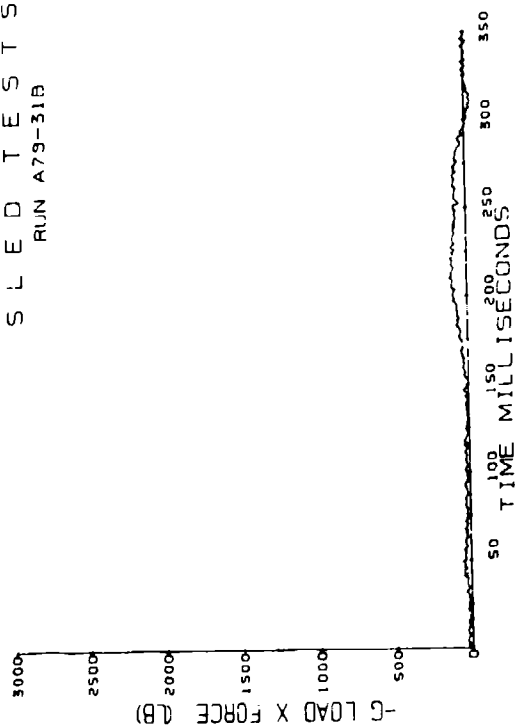
CAMI
S L E D T E S T S
RUN A79-31B

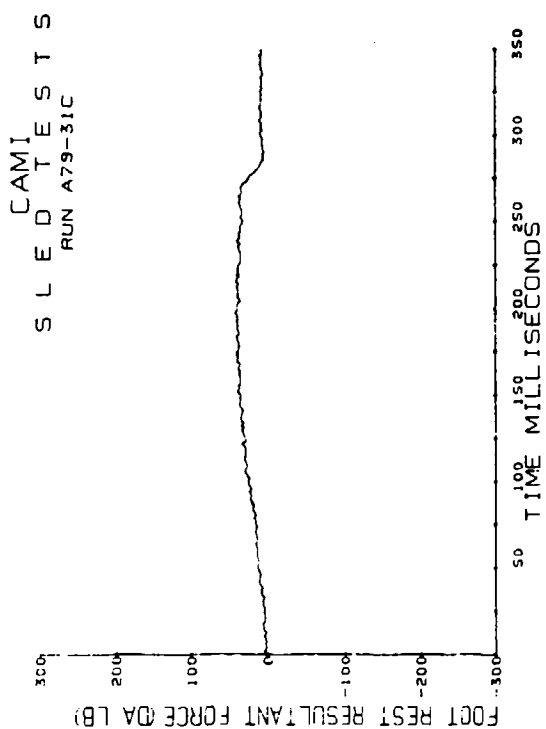
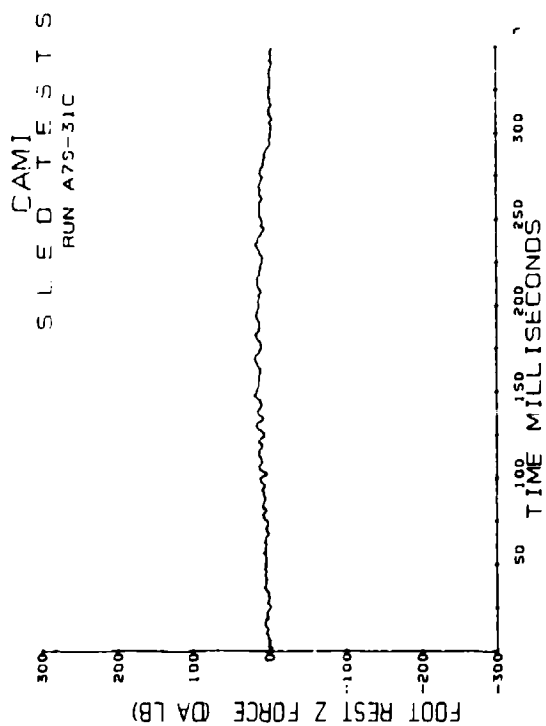
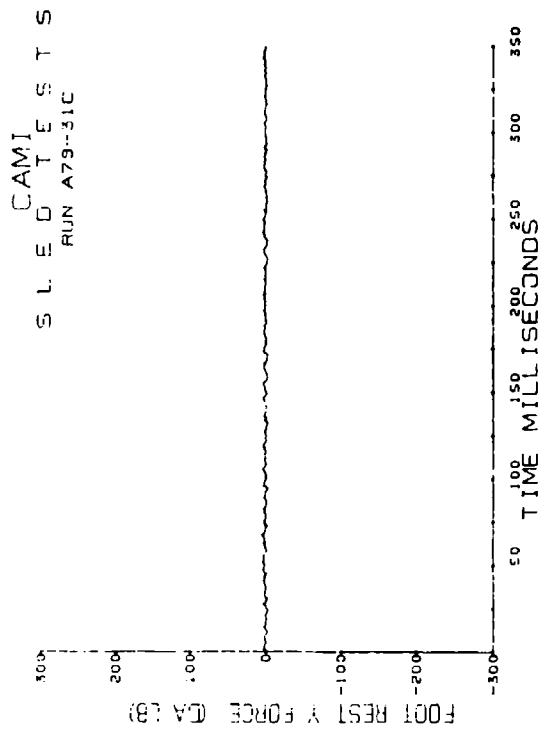
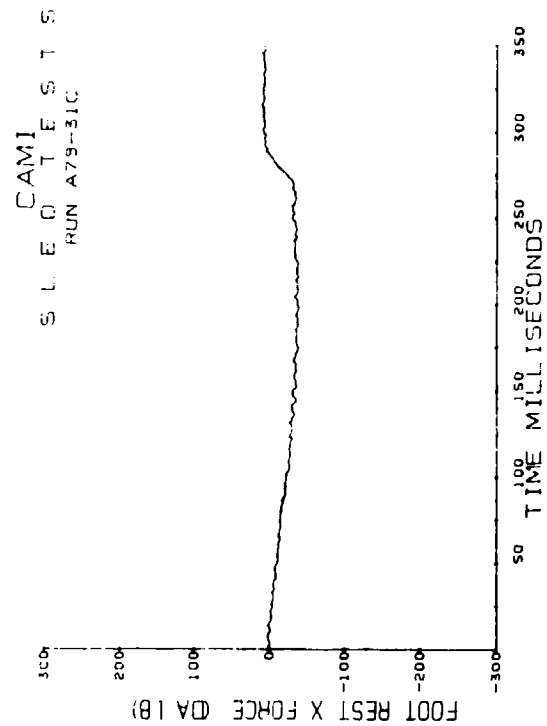


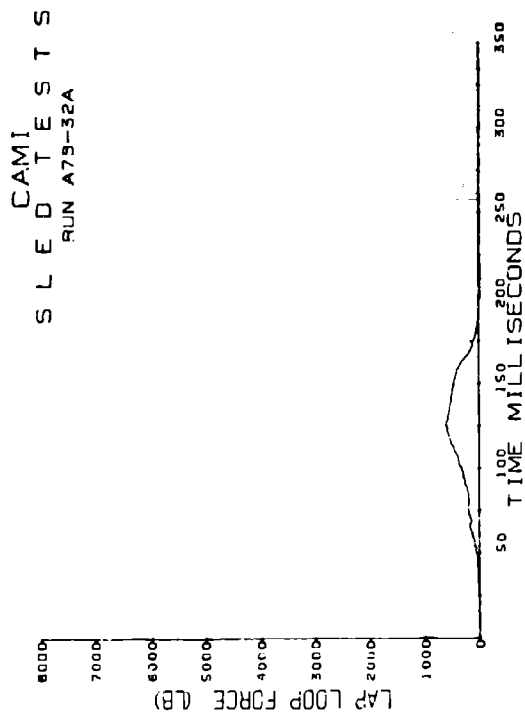
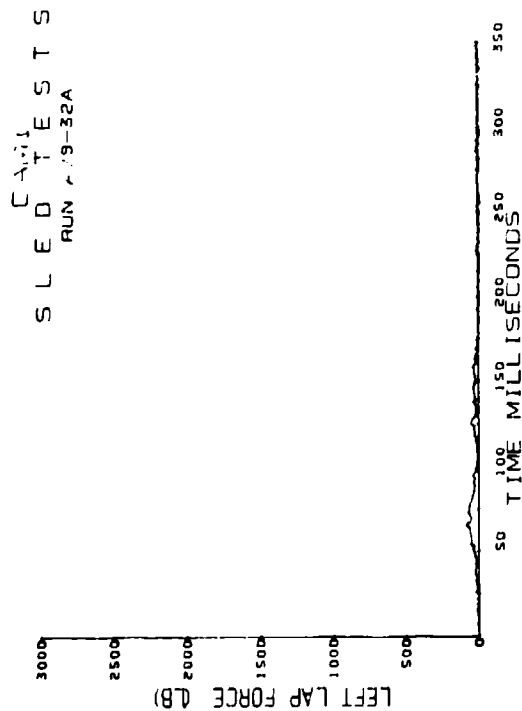
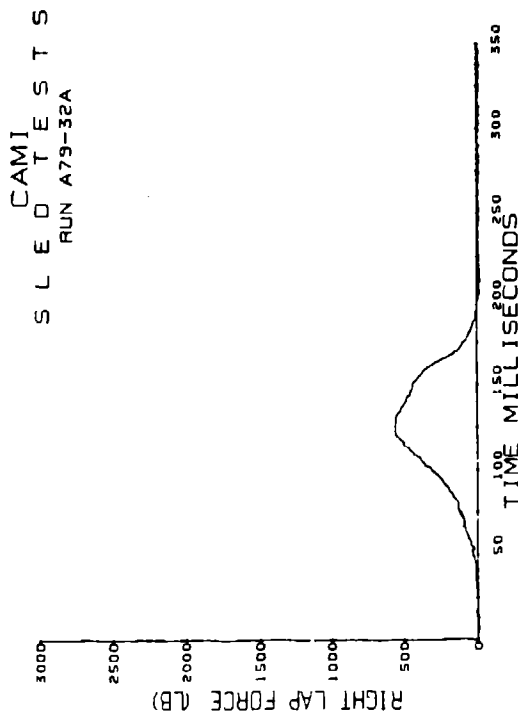
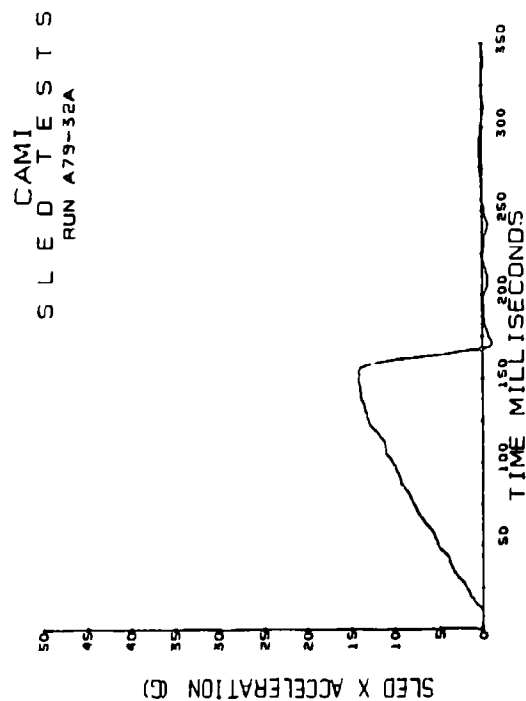
CAMI
S L E D T E S T S
RUN A79-31B



CAMI
S L E D T E S T S
RUN A79-31B

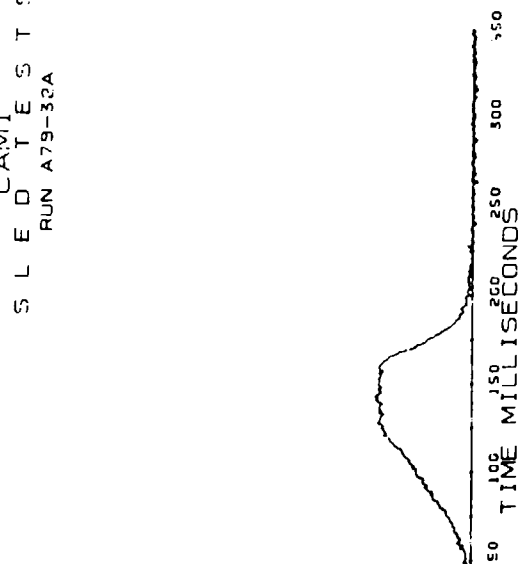






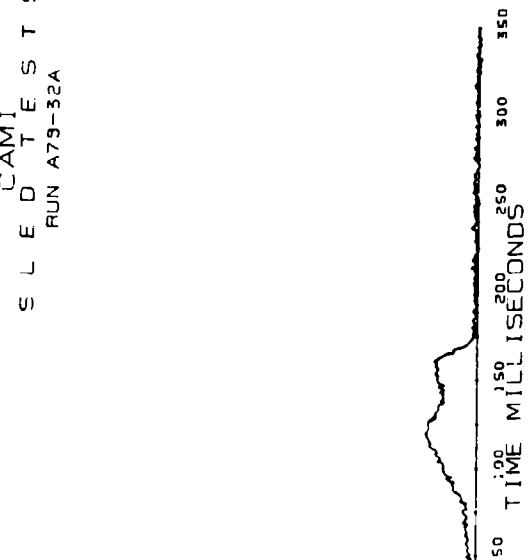
CAMI
S L E D T E S T S
RUN A79-32A

LEFT SHOULDER FORCE (LB)



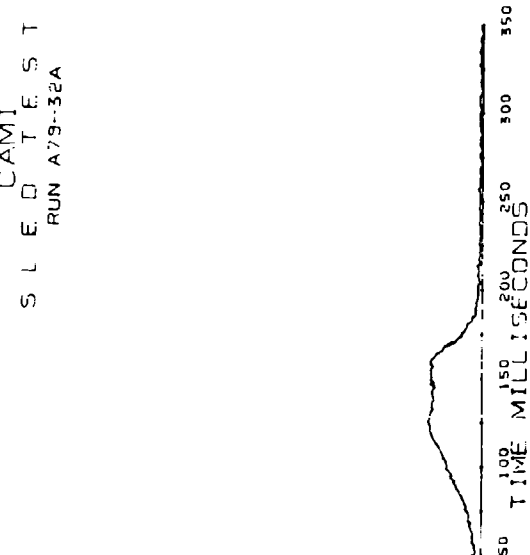
CAMI
S L E D T E S T S
RUN A79-32A

RIGHT SHOULDER FORCE (LB)

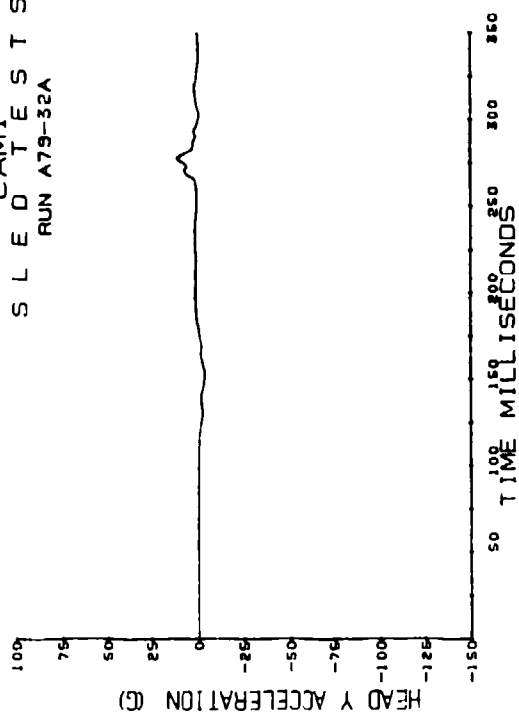


CAMI
S L E D T E S T S
RUN A79-32A

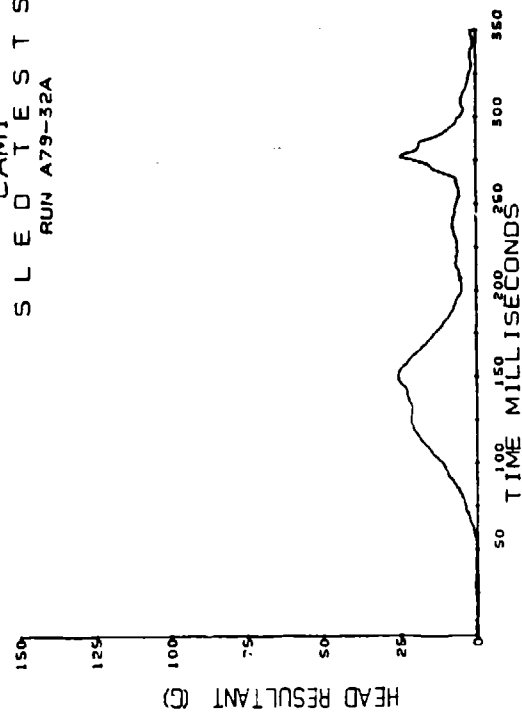
SHOULDER FORCE SUM (LB)



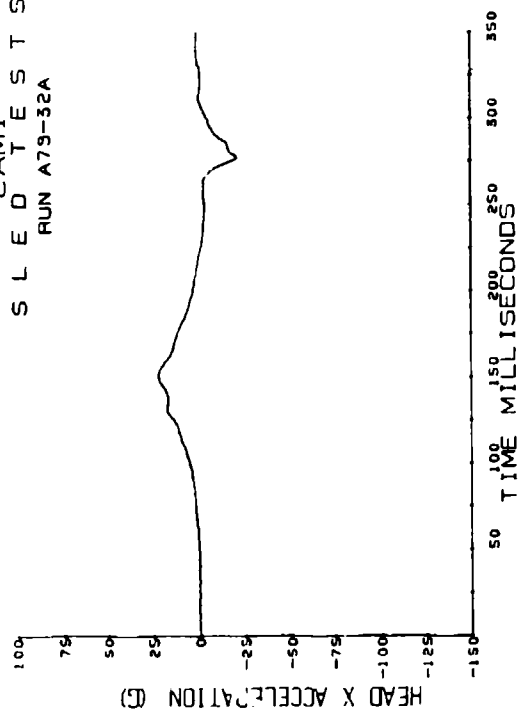
CAMI
S L E D T E S T S
RUN A79-32A



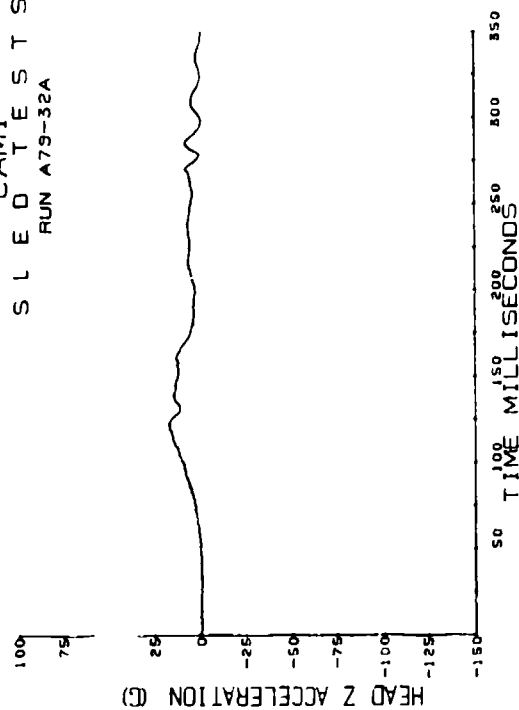
CAMI
S L E D T E S T S
RUN A79-32A

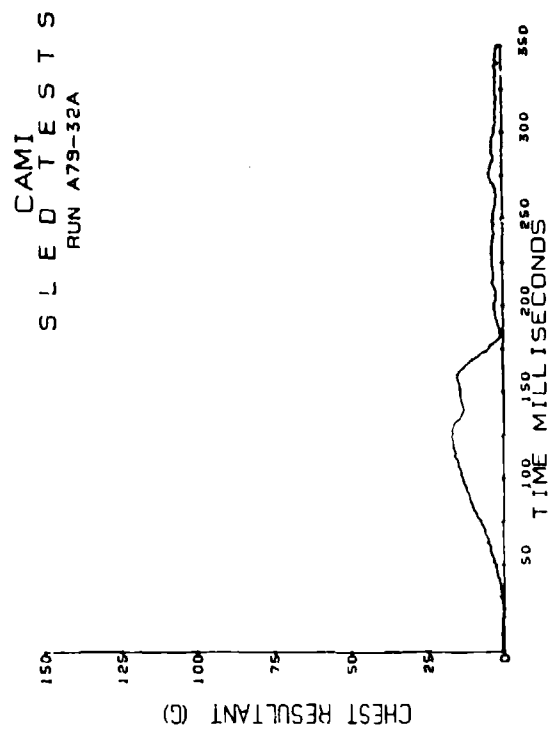
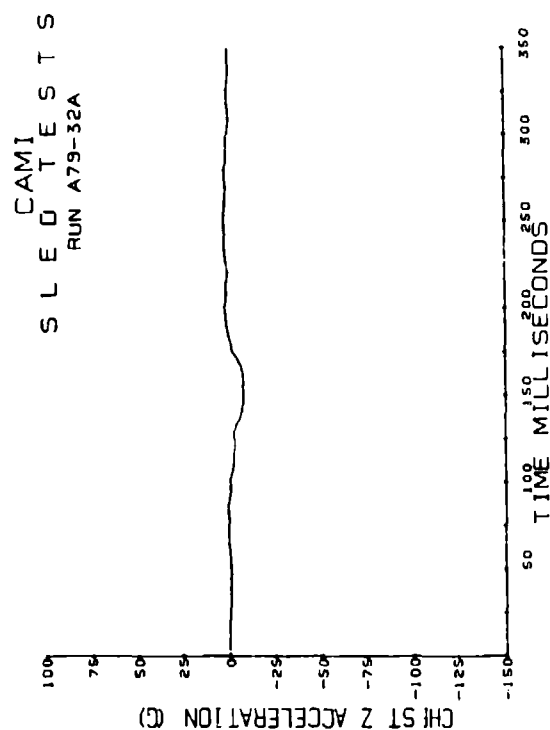
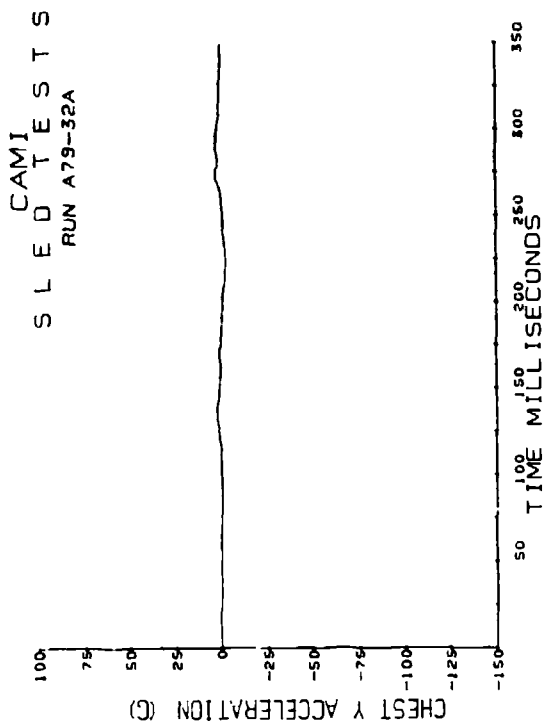
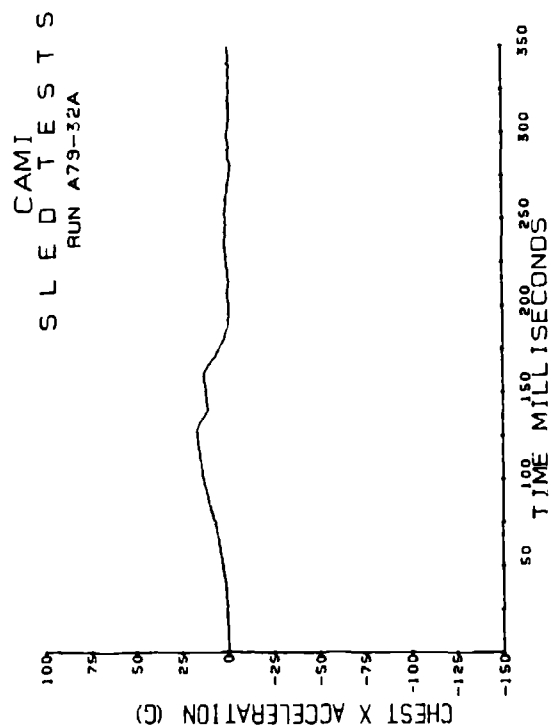


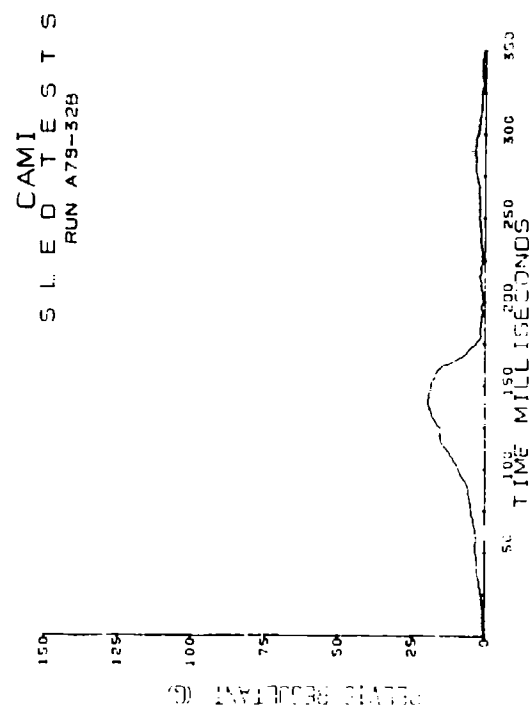
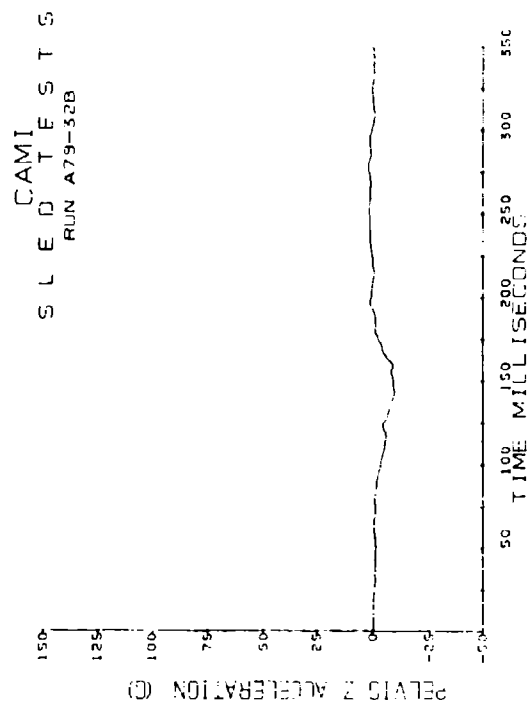
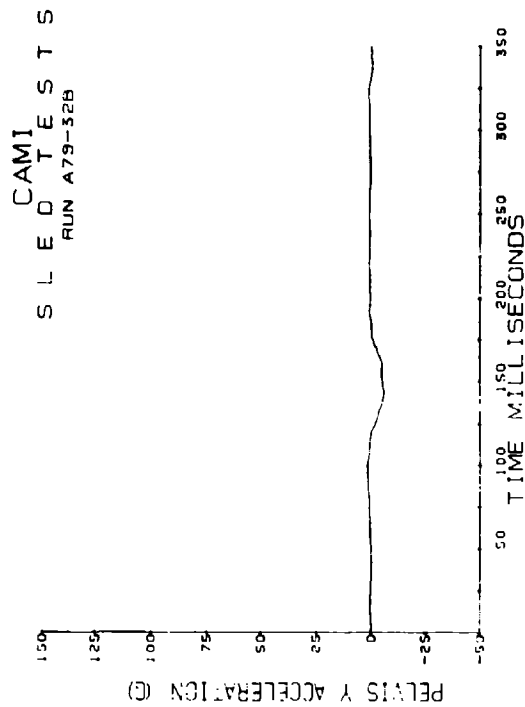
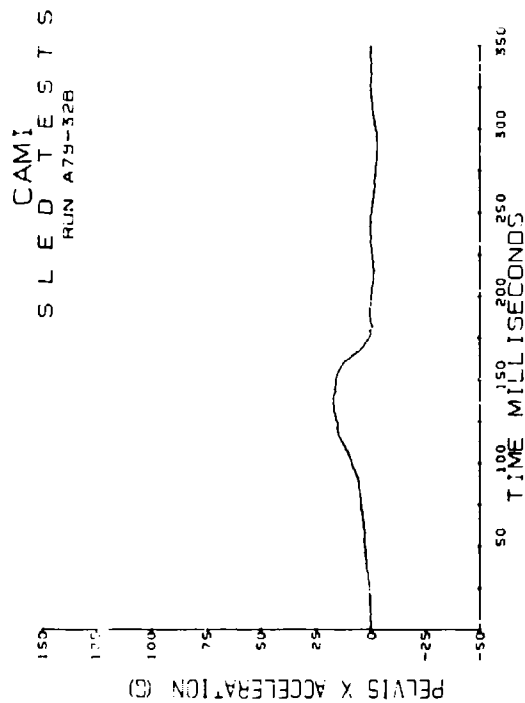
CAMI
S L E D T E S T S
RUN A79-32A



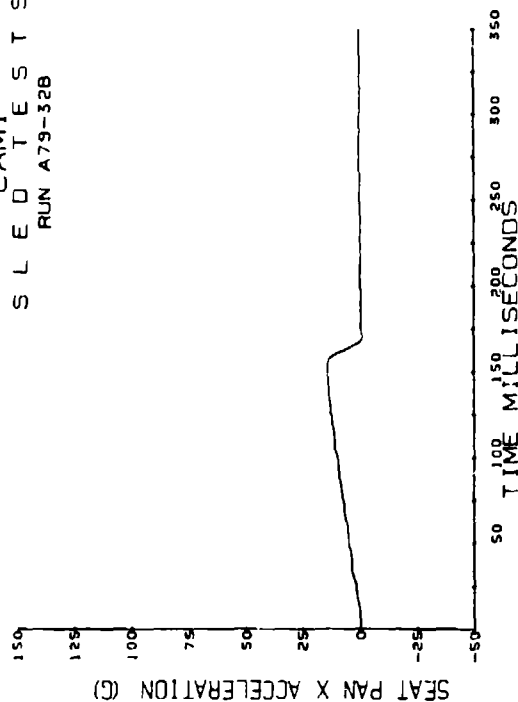
CAMI
S L E D T E S T S
RUN A79-32A



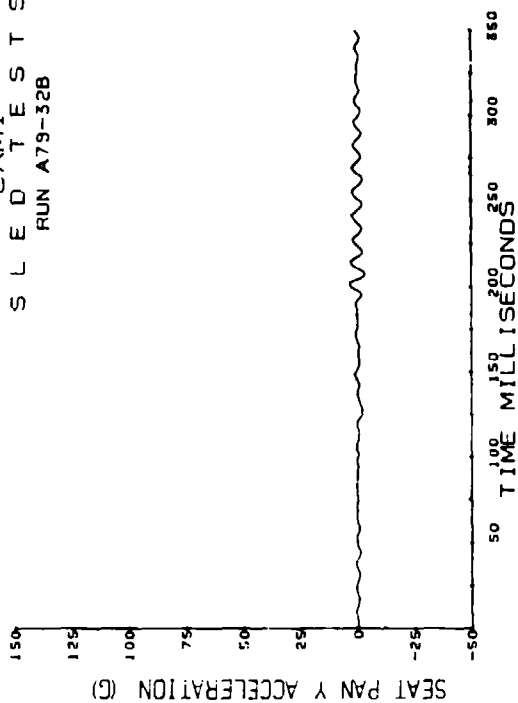




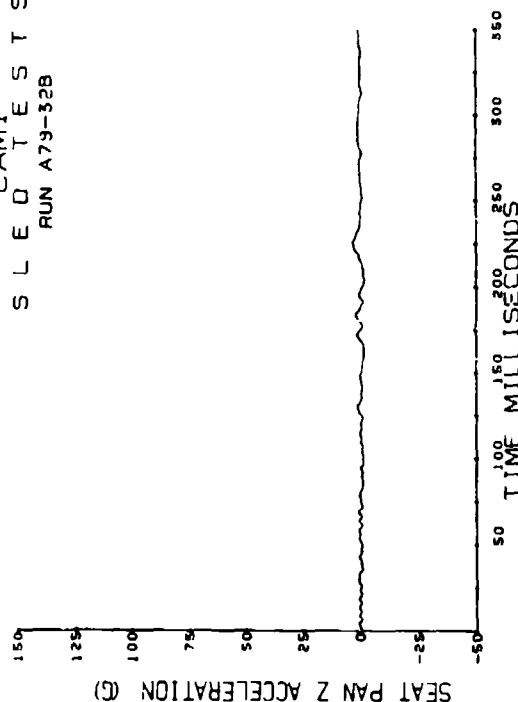
CAMI
S L E D T E S T S
RUN A79-32B



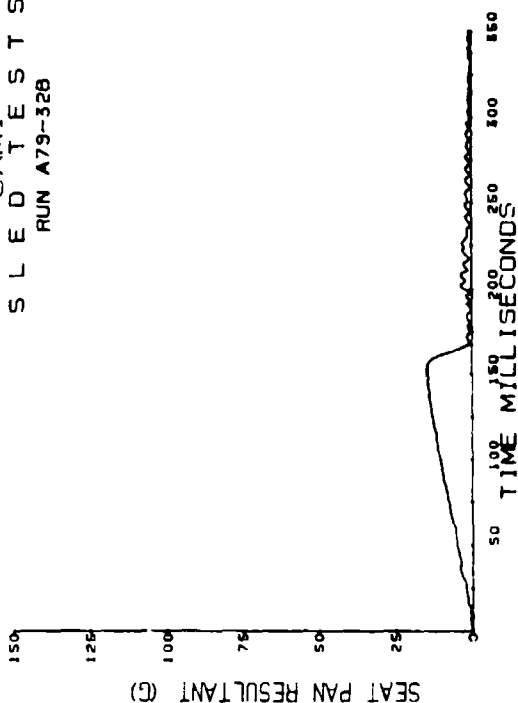
CAMI
S L E D T E S T S
RUN A79-32B

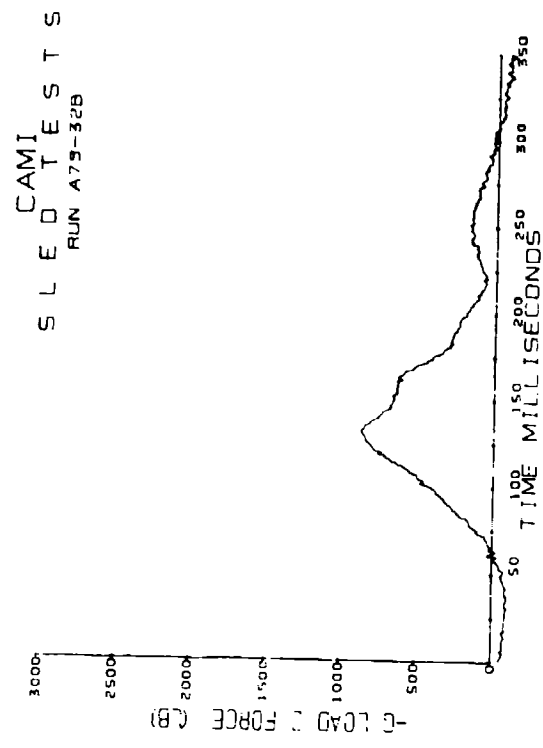
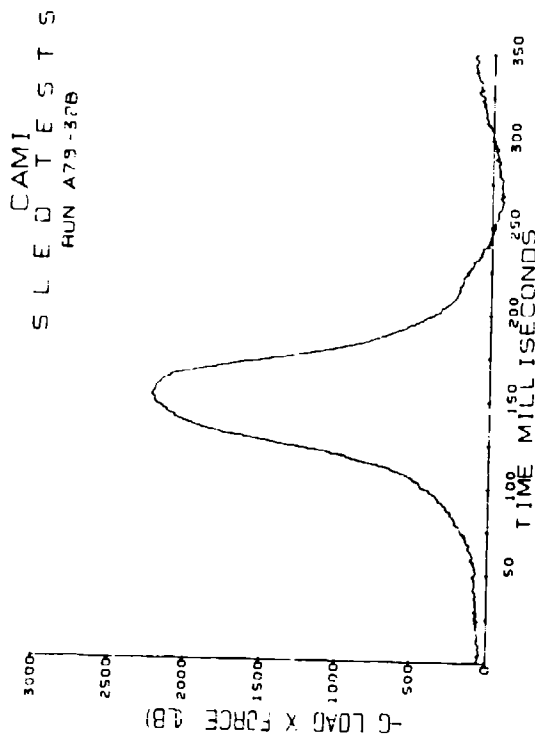


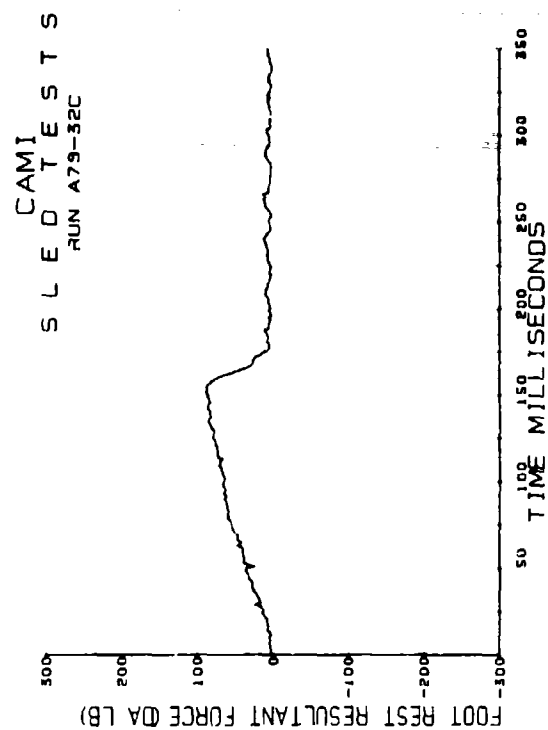
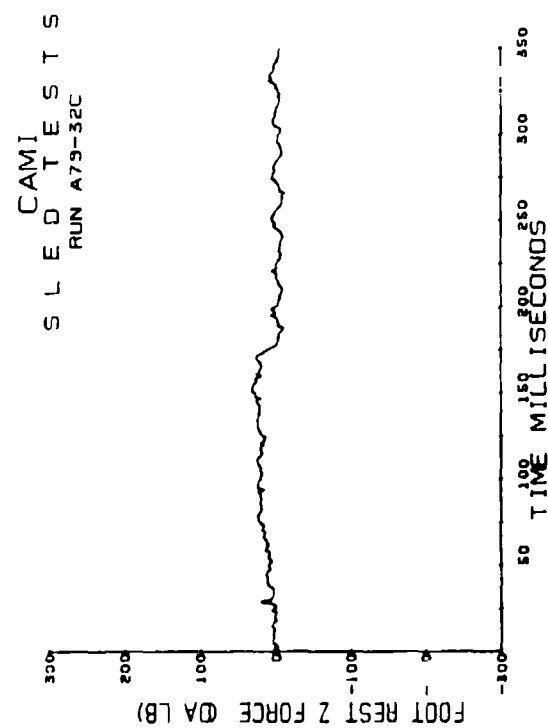
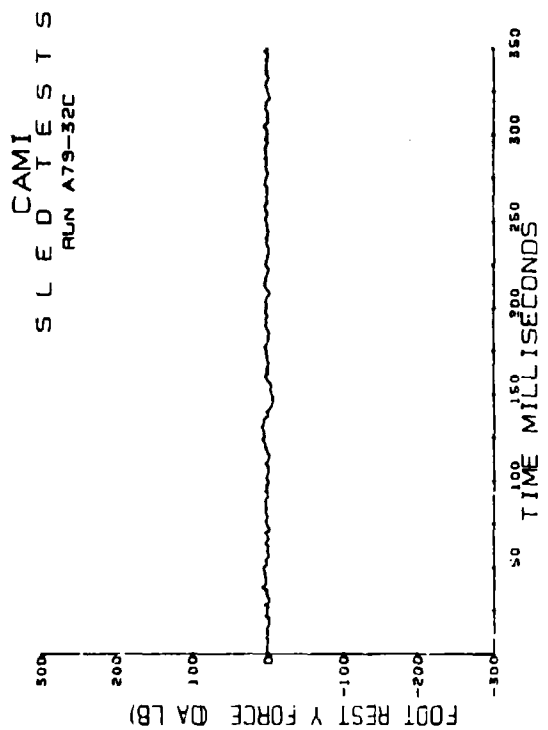
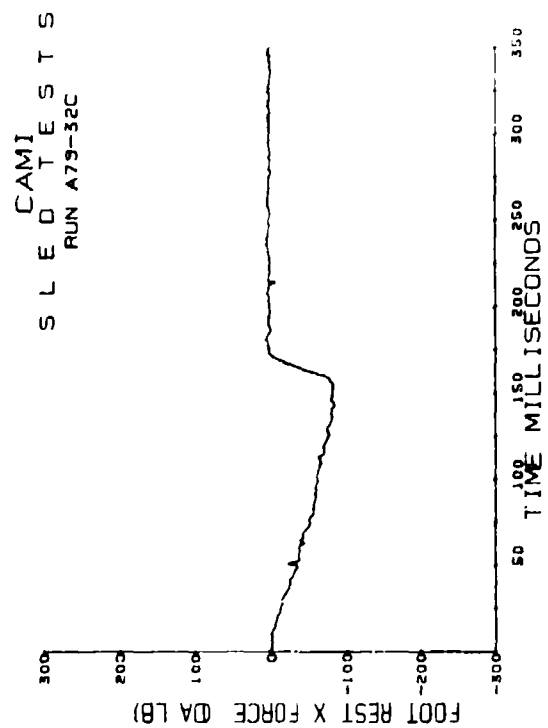
CAMI
S L E D T E S T S
RUN A79-32B



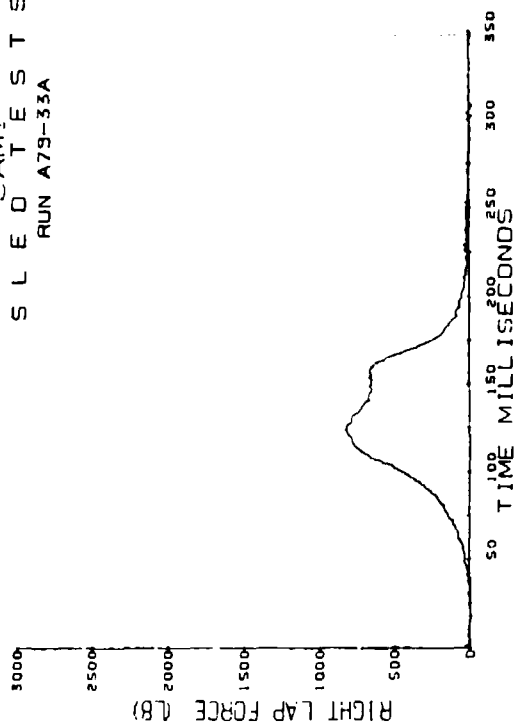
CAMI
S L E D T E S T S
RUN A79-32B



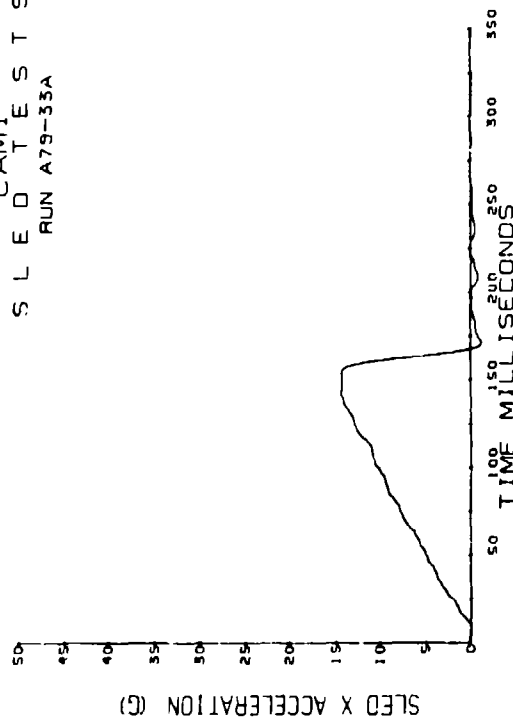




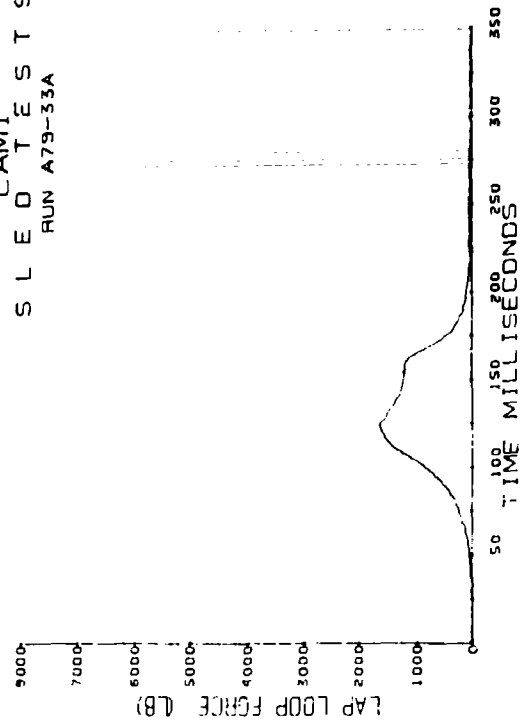
CAMI
S L E D T E S T S
RUN A79-33A



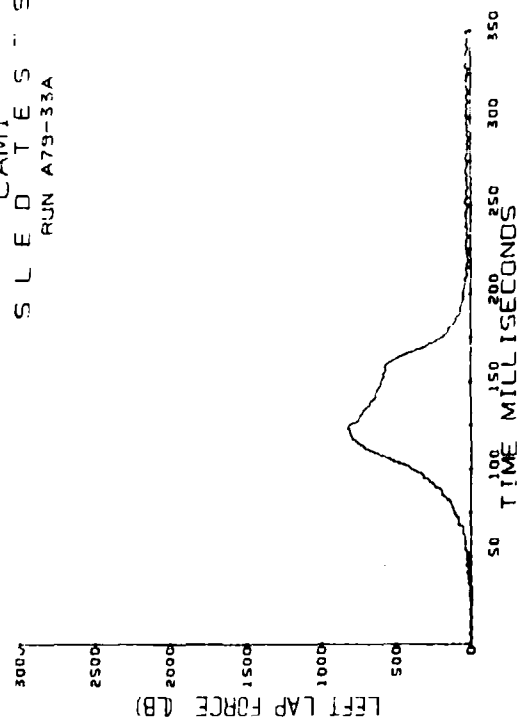
CAMI
S L E D T E S T S
RUN A79-33A

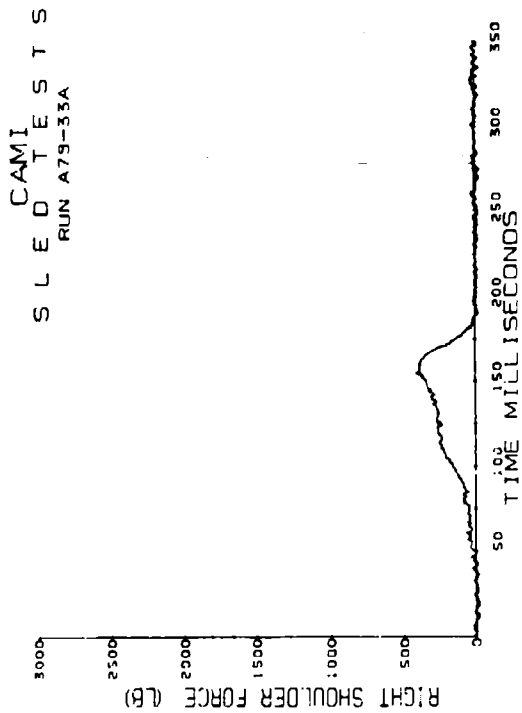
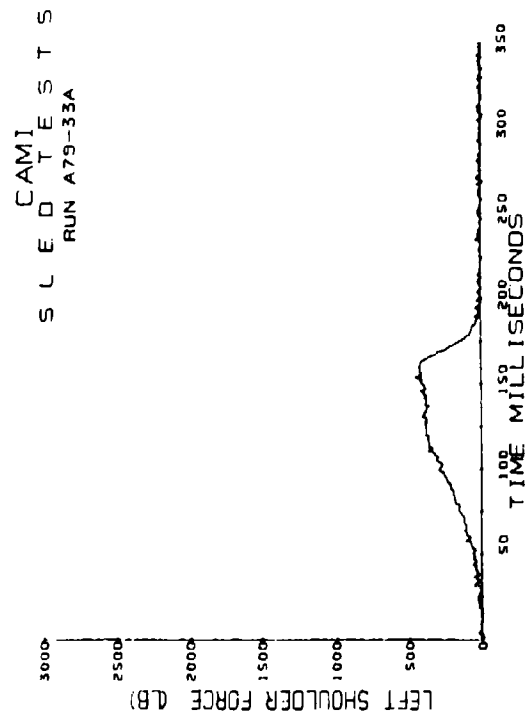


CAMI
S L E D T E S T S
RUN A79-33A

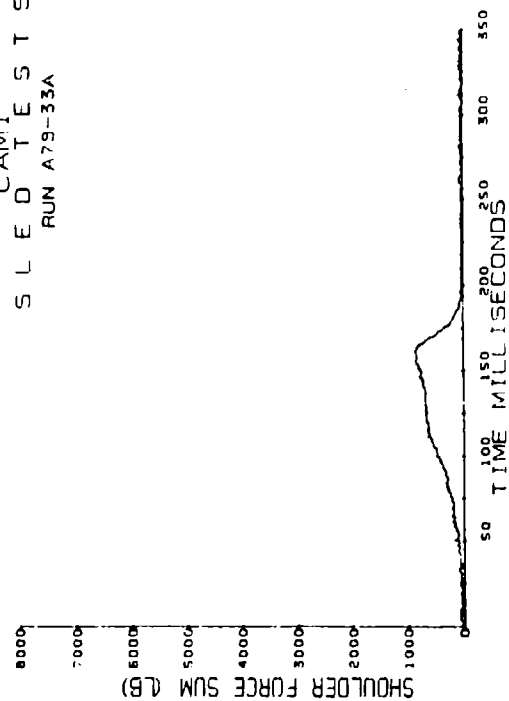


CAMI
S L E D T E S T S
RUN A79-33A

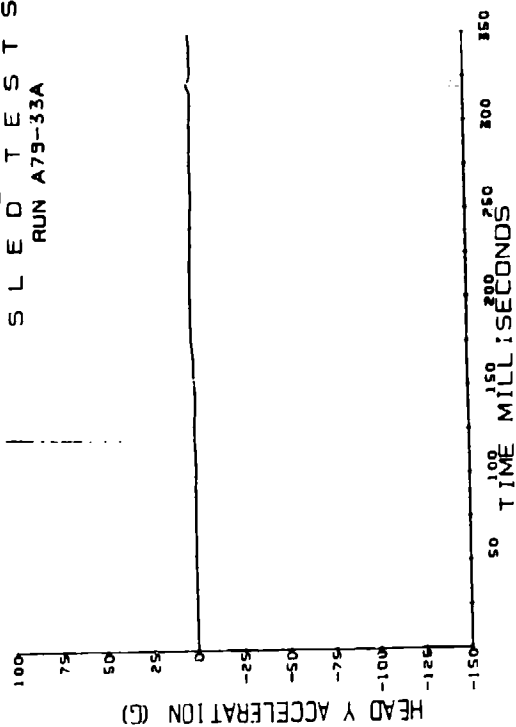




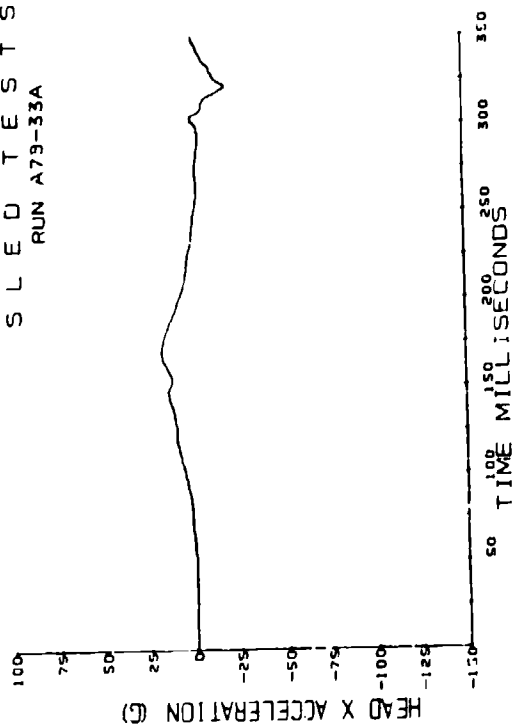
CAMI
S L E D T E S T S
RUN A79-33A



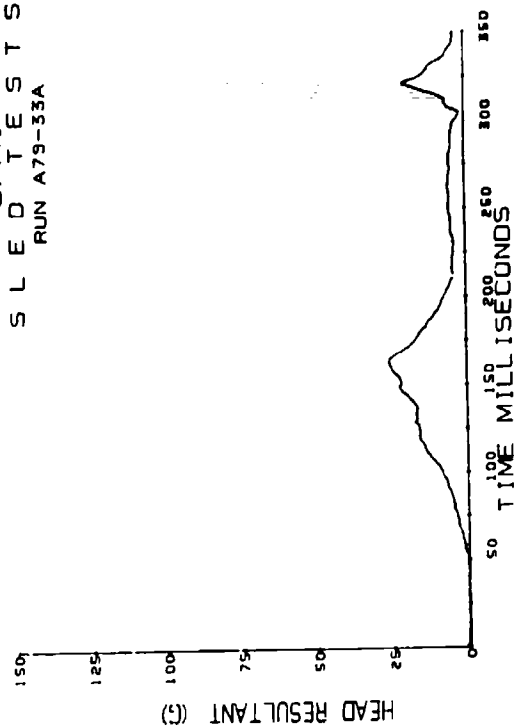
CAMI
S L E D T E S T S
RUN A79-33A



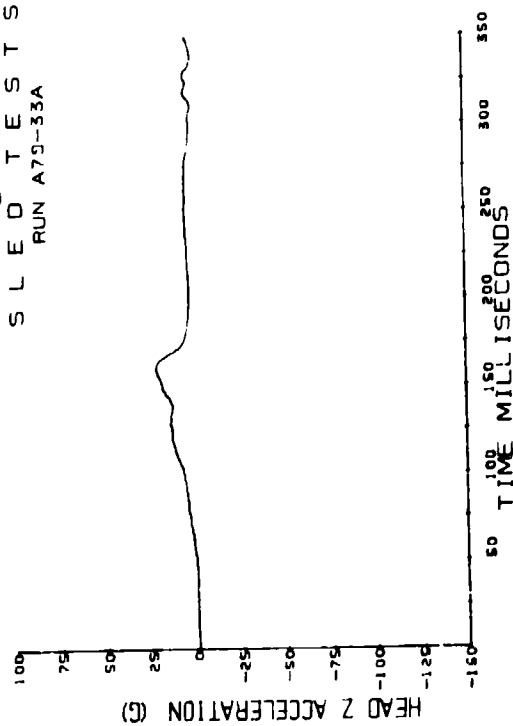
CAMI
S L E D T E S T S
RUN A79-33A

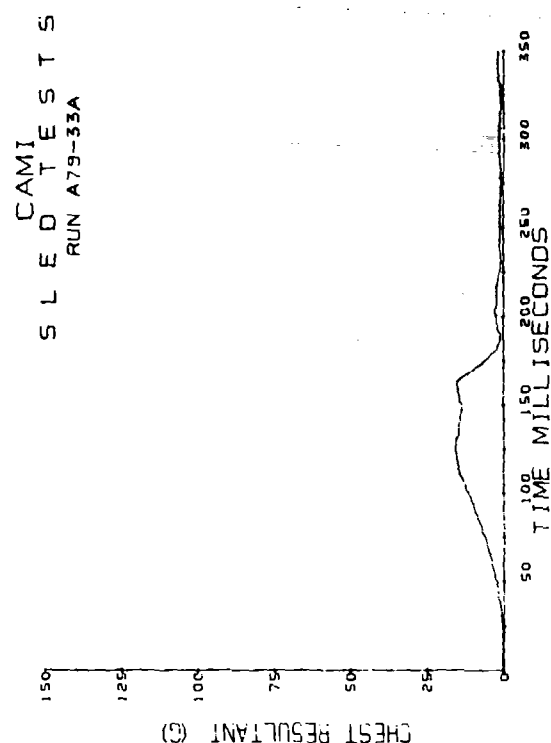
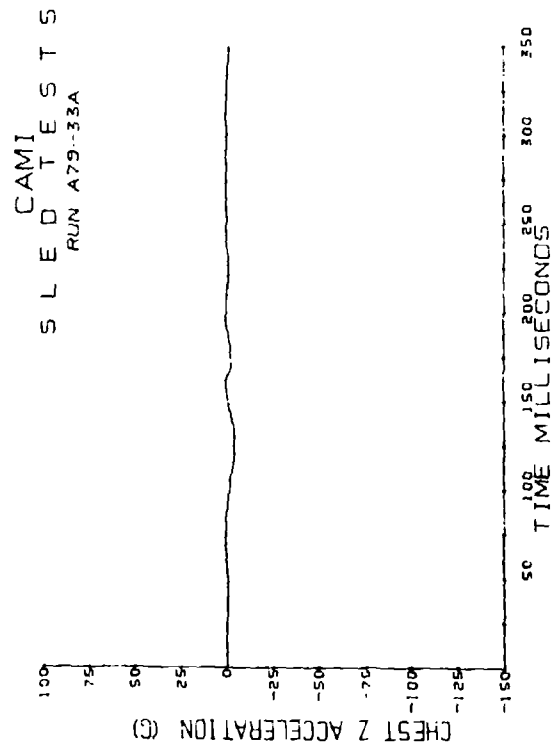
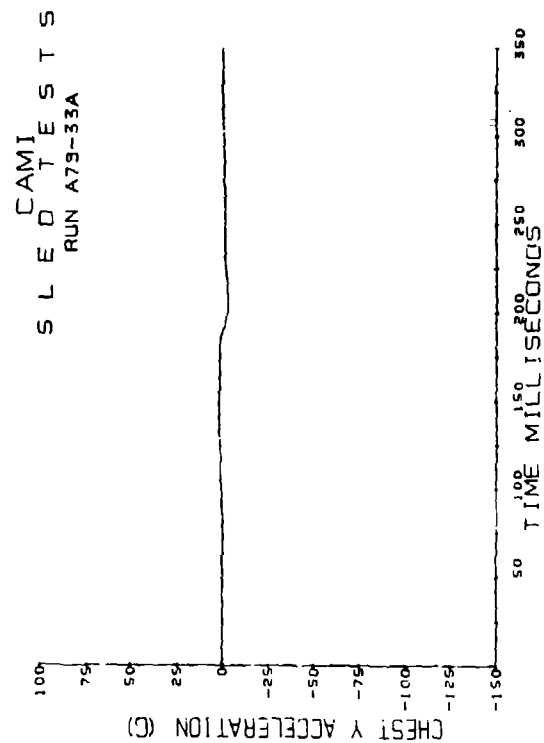
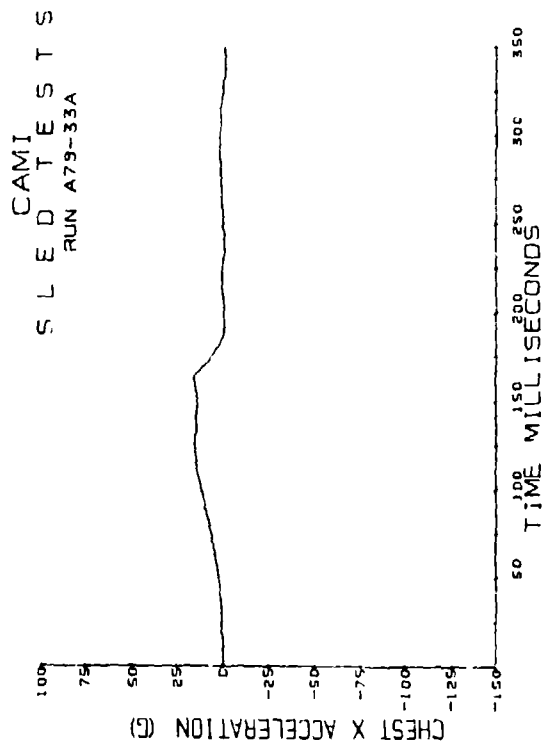


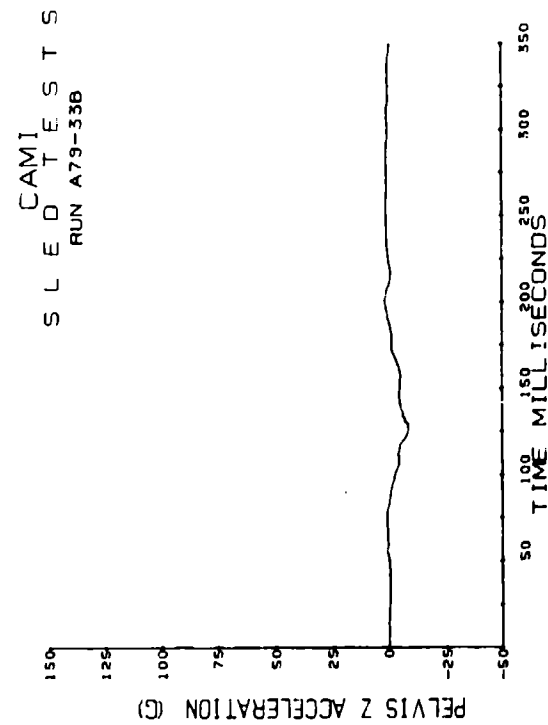
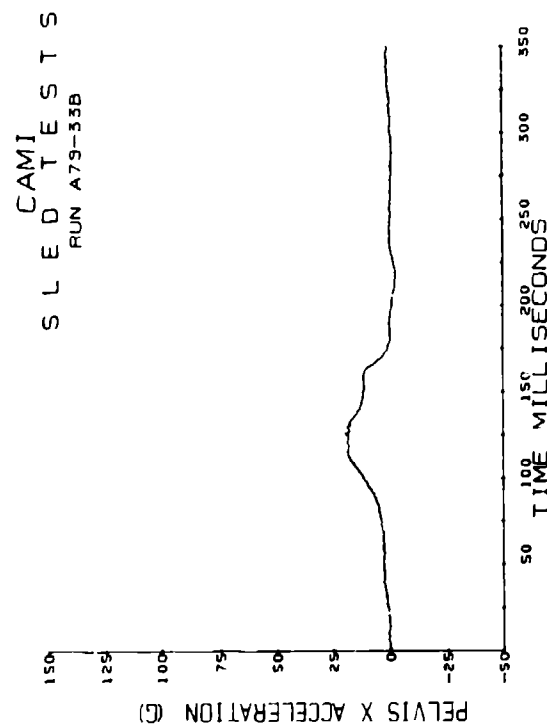
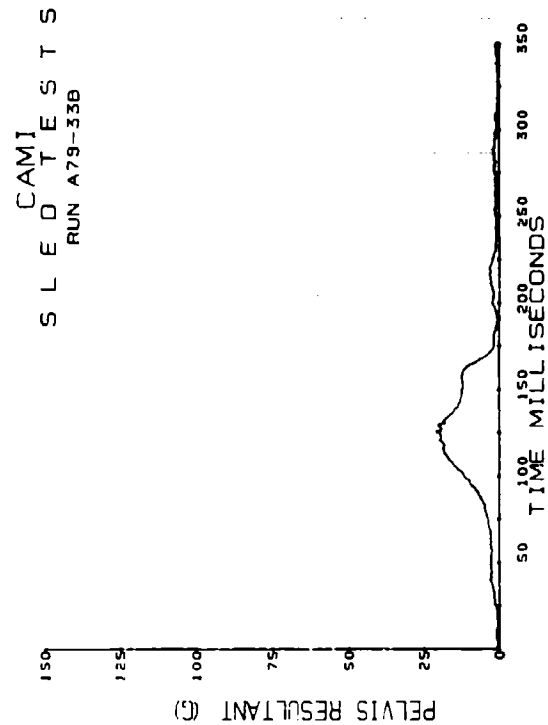
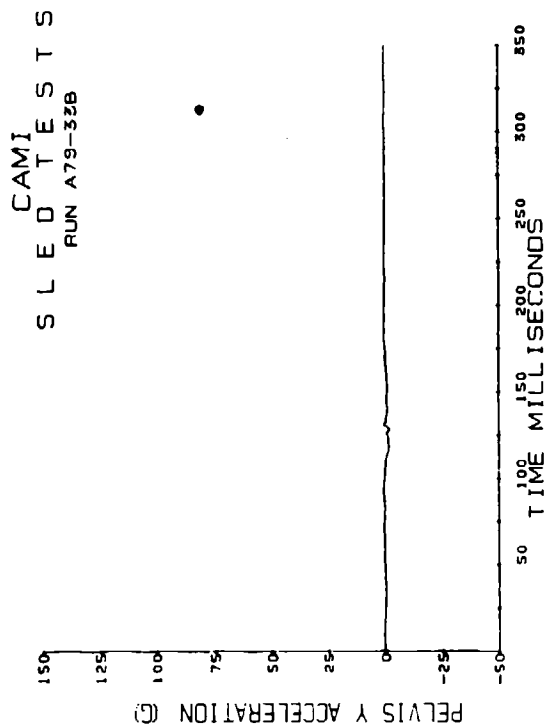
CAMI
S L E D T E S T S
RUN A79-33A



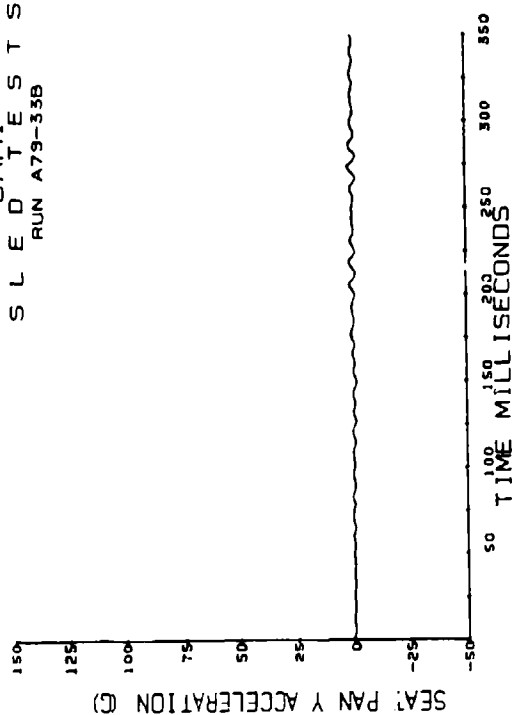
CAMI
S L E D T E S T S
RUN A79-33A



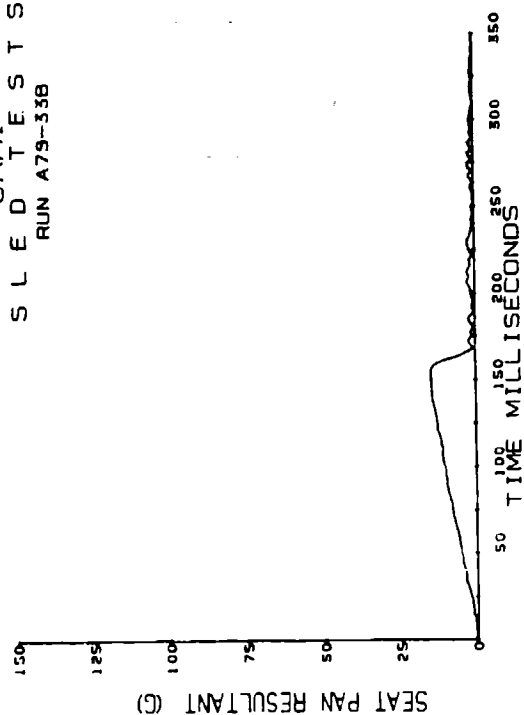




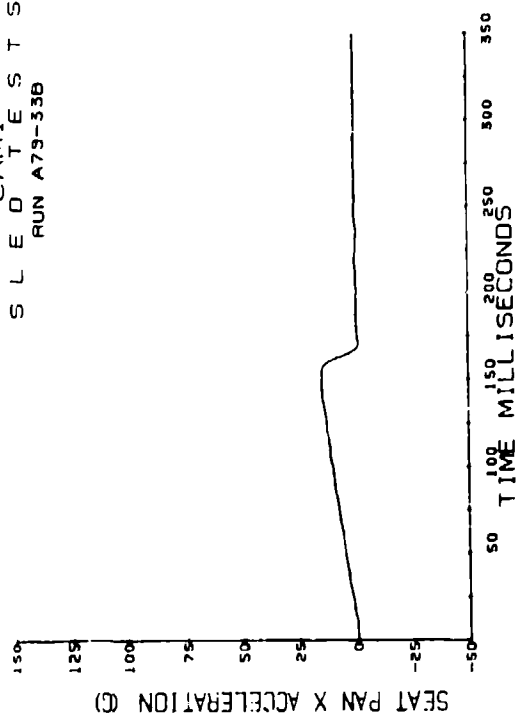
CAMI
S L E D T E S T S
RUN A79-33B



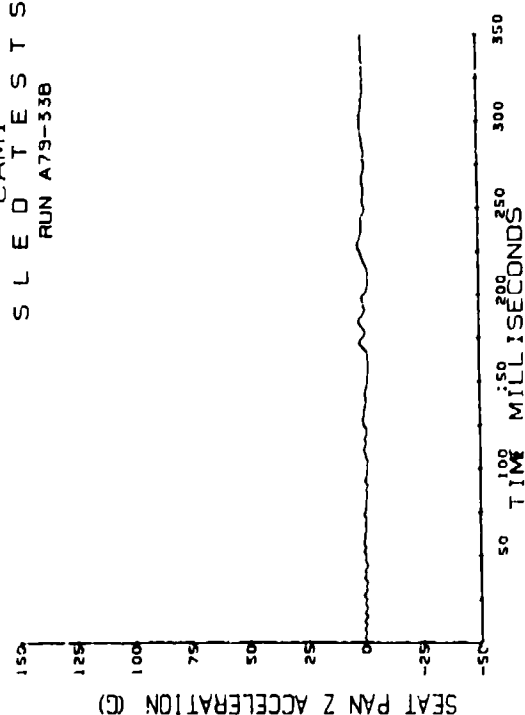
CAMI
S L E D T E S T S
RUN A79-33B



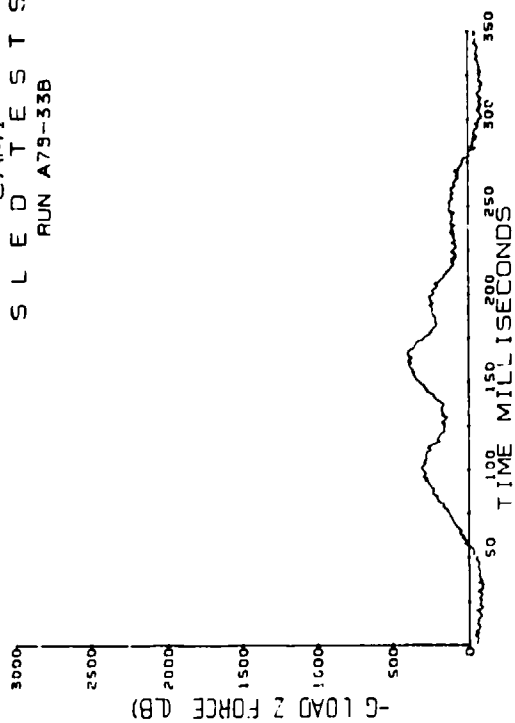
CAMI
S L E D T E S T S
RUN A79-33B



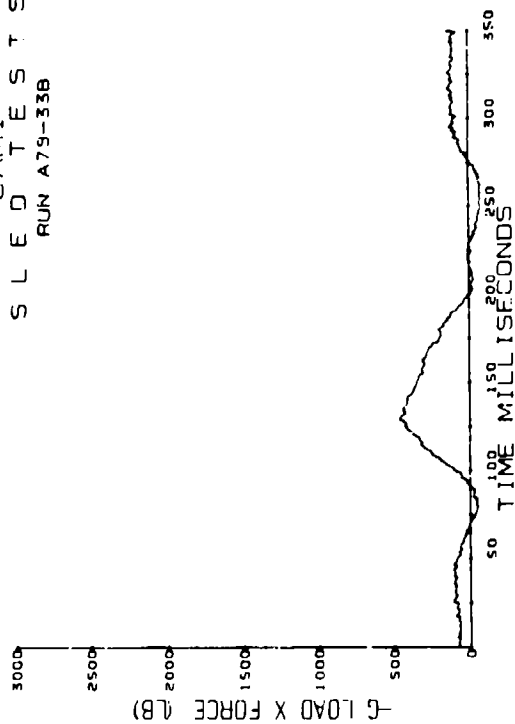
CAMI
S L E D T E S T S
RUN A79-33B

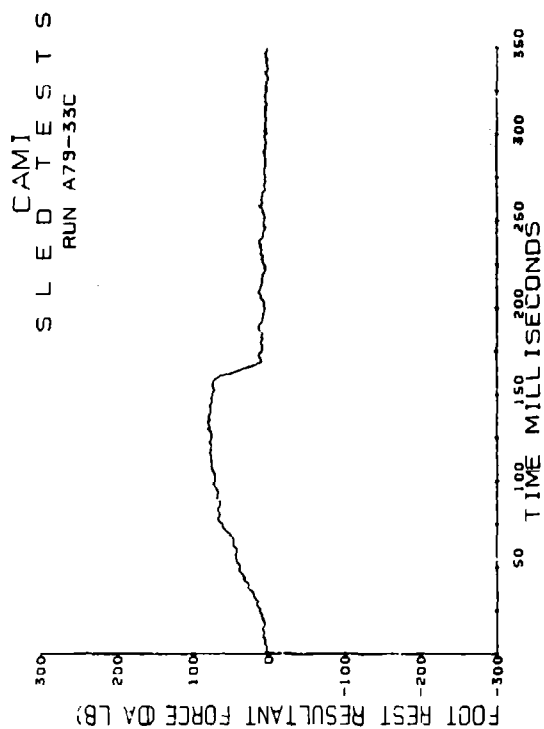
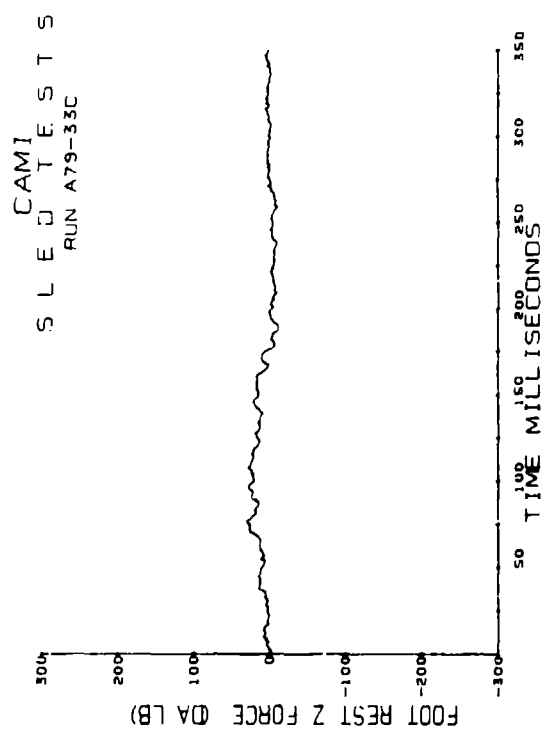
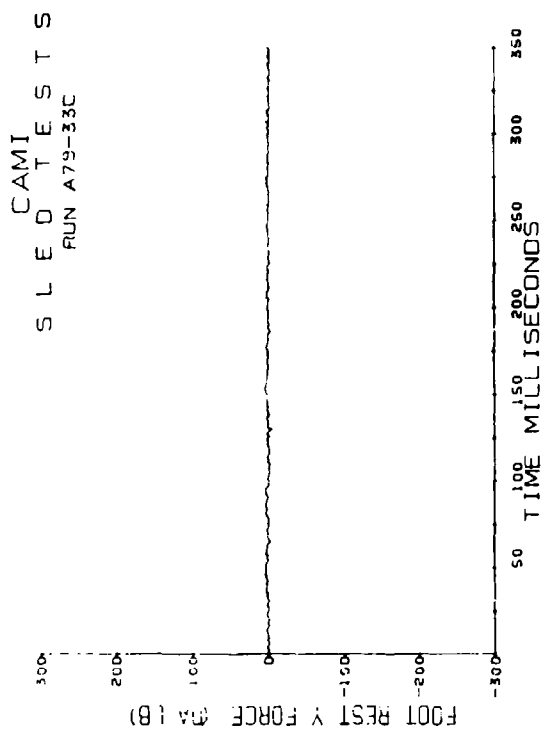
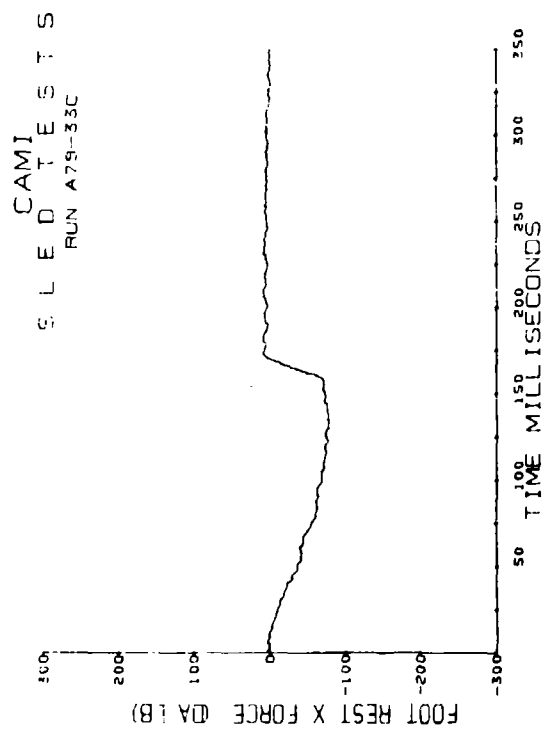


CAMI
S L E D T E S T S
RUN A79-33B

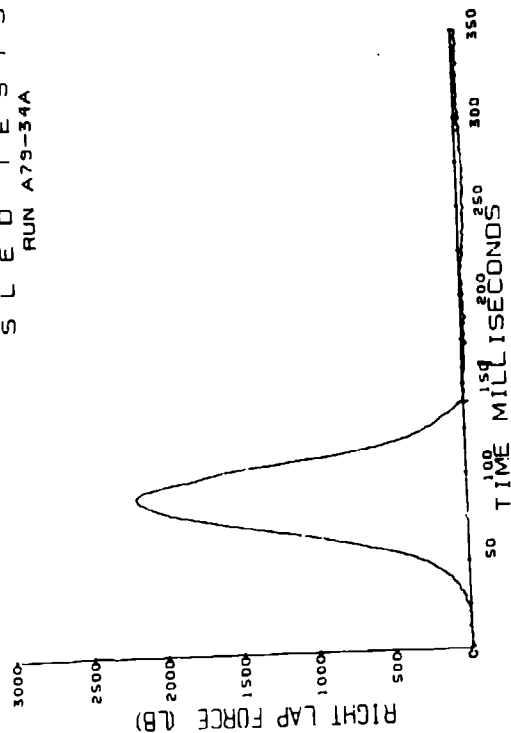


CAMI
S L E D T E S T S
RUN A79-33B

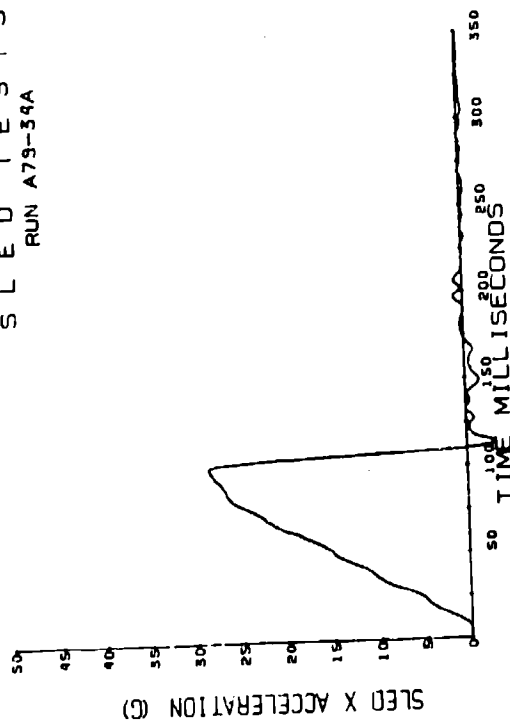




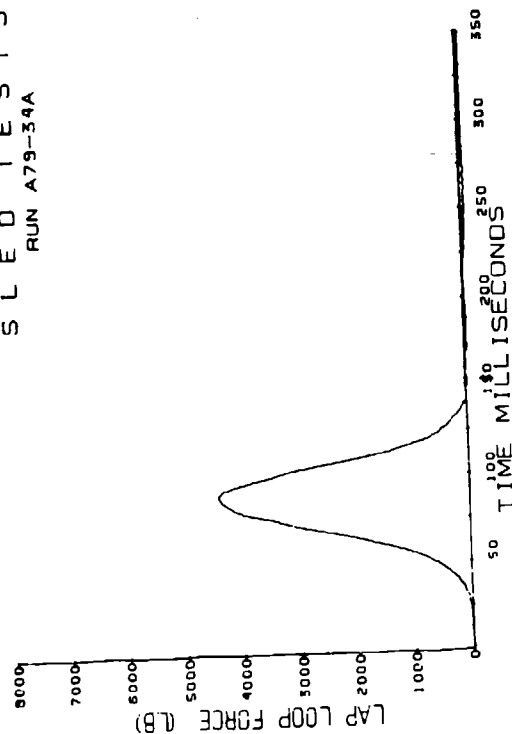
CAMI
S L E D T E S T S
RUN A79-34A



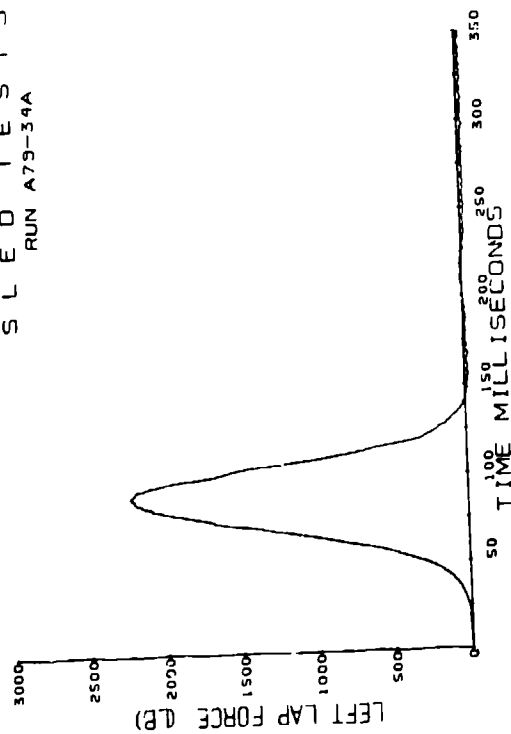
CAMI
S L E D T E S T S
RUN A79-34A

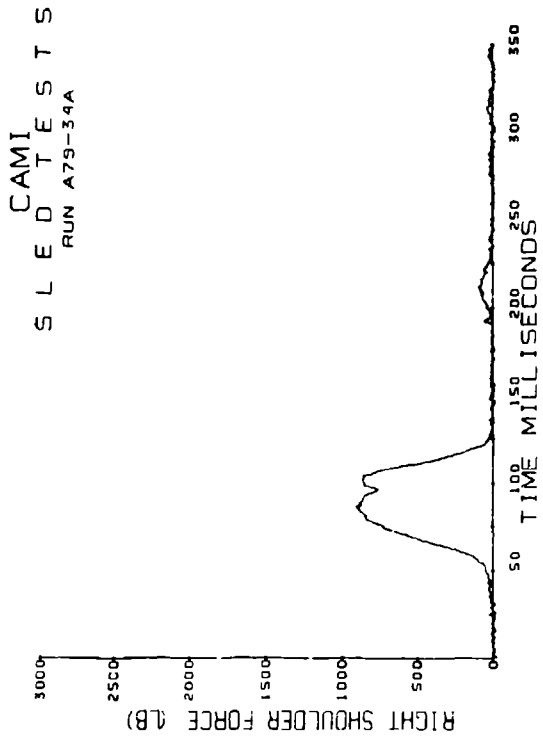
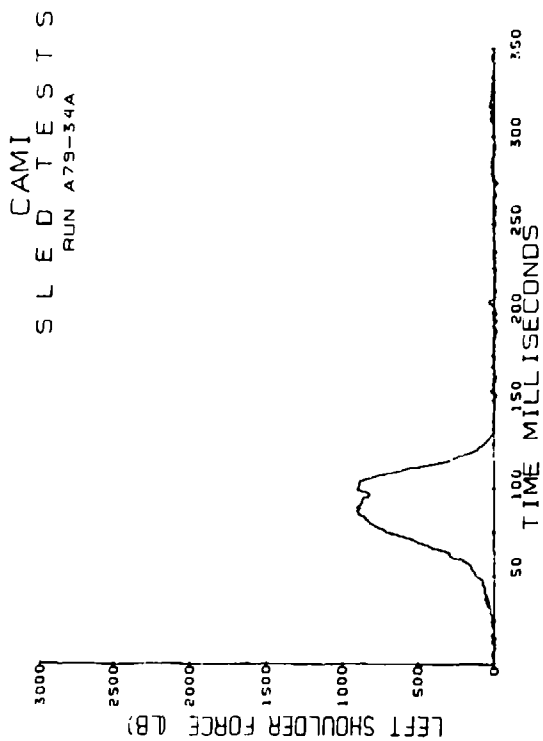


CAMI
S L E D T E S T S
RUN A79-34A

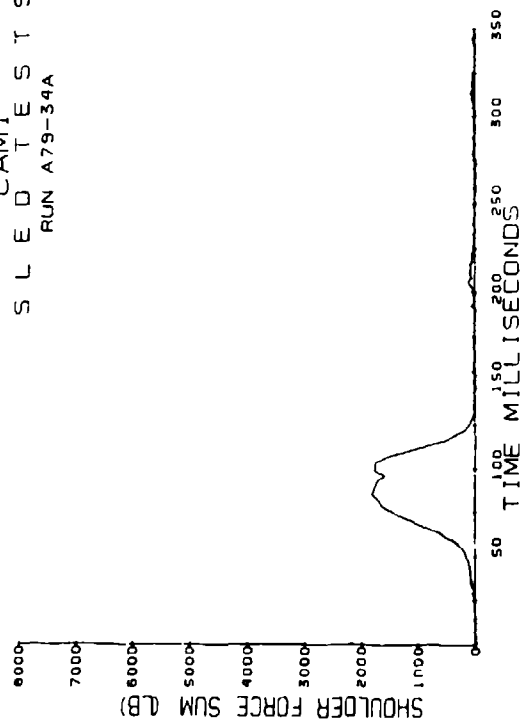


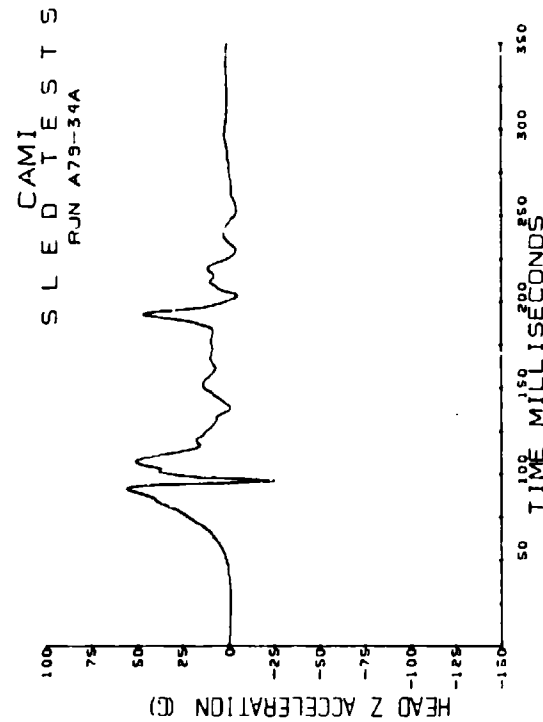
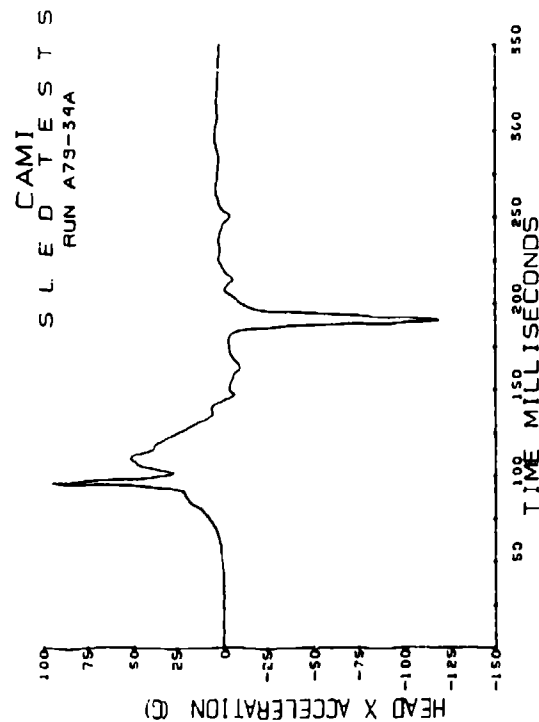
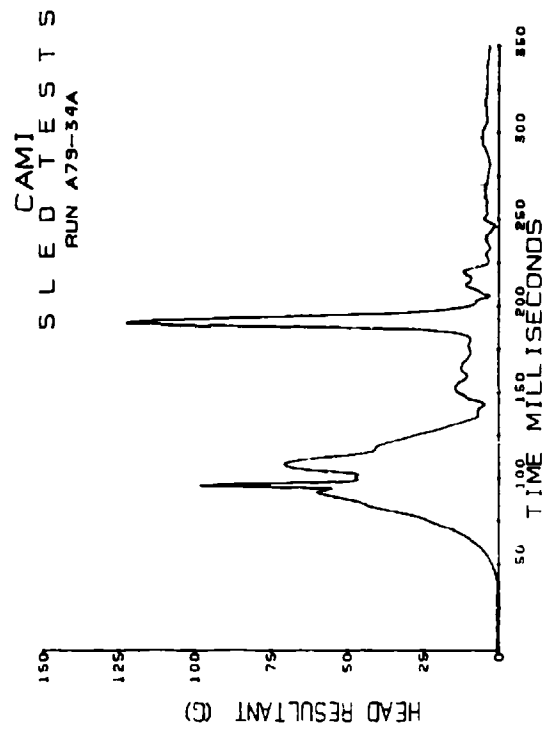
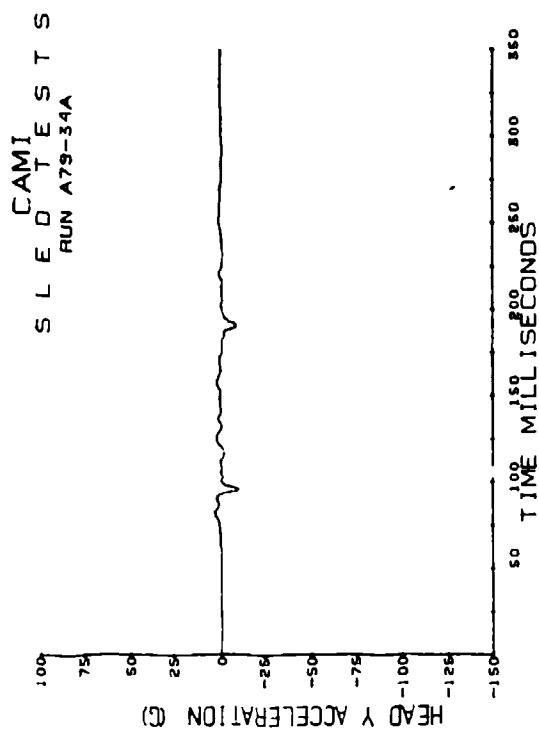
CAMI
S L E D T E S T S
RUN A79-34A

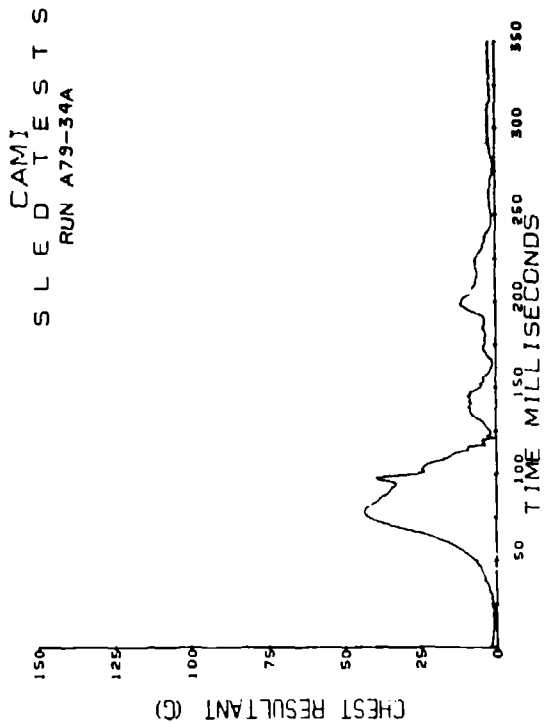
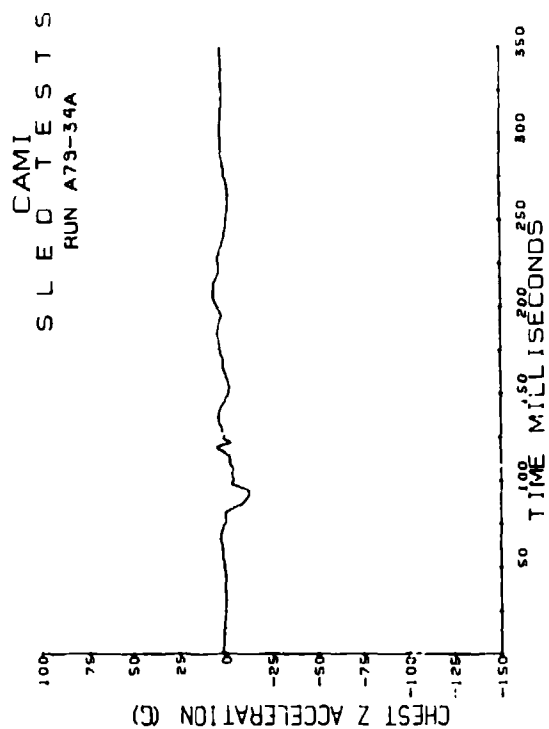
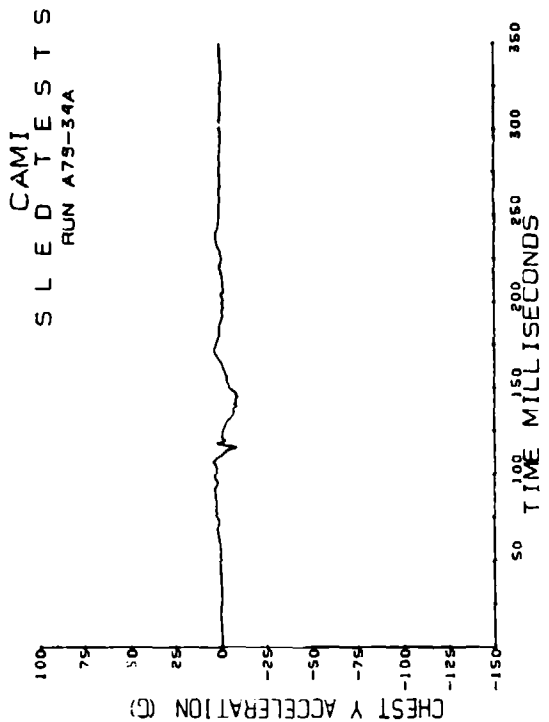
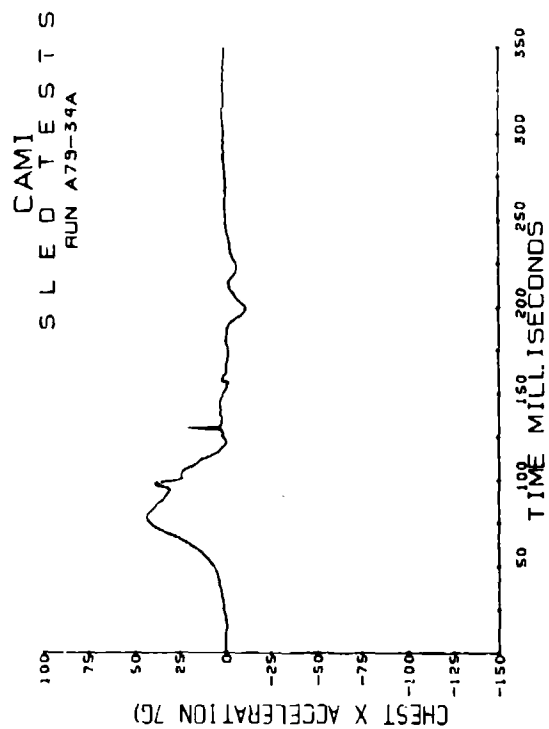




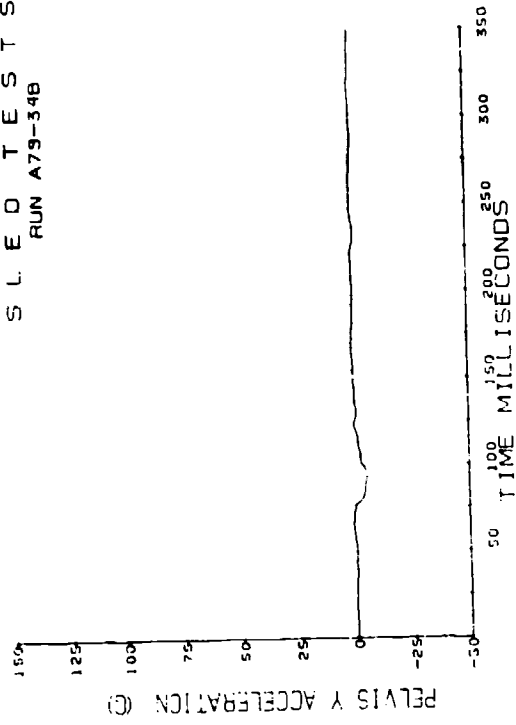
CAMI
S L E D T E S T S
RUN A79-34A



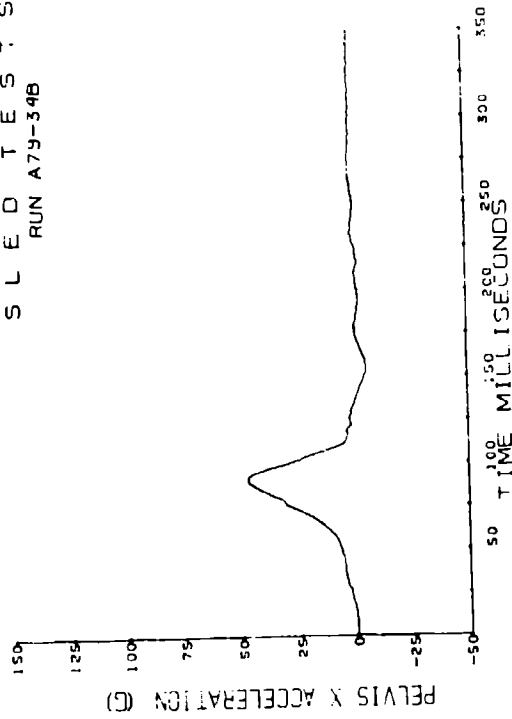




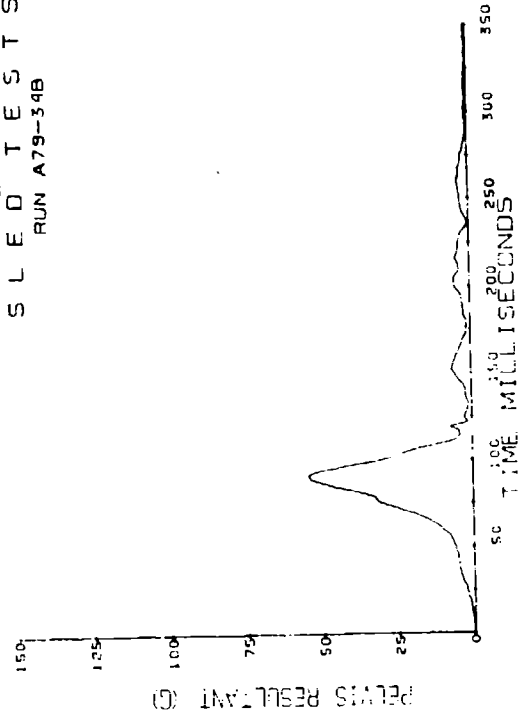
CAMI
S L E D T E S T S
RUN A79-34B



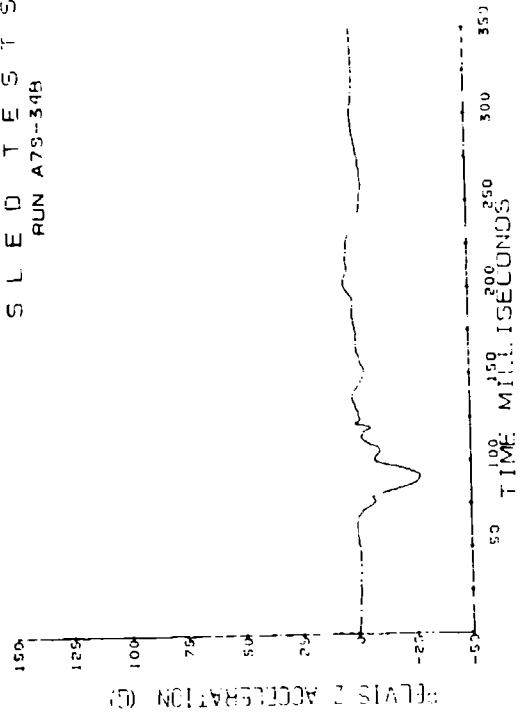
CAMI
S L E D T E S T S
RUN A79-34B

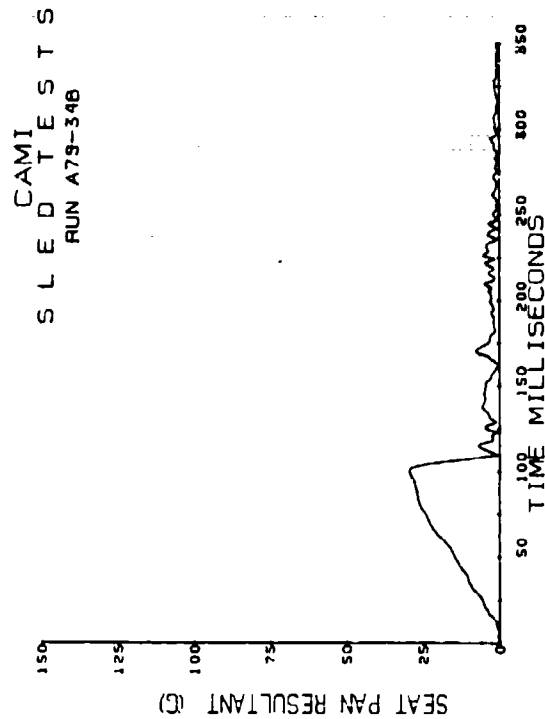
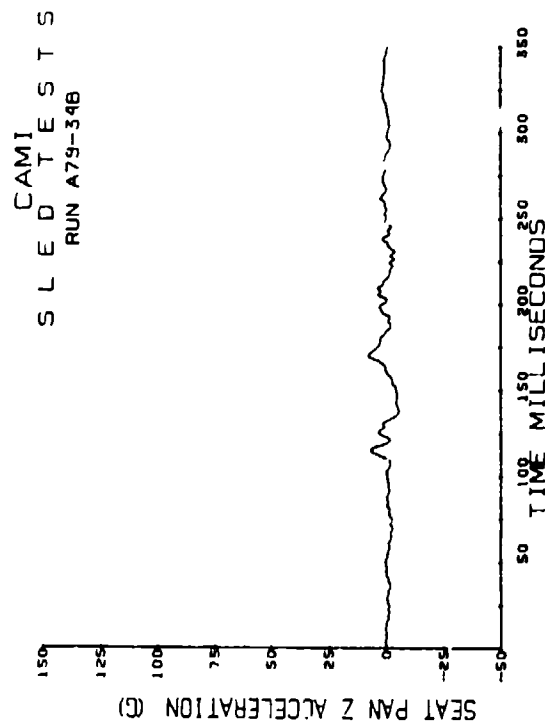
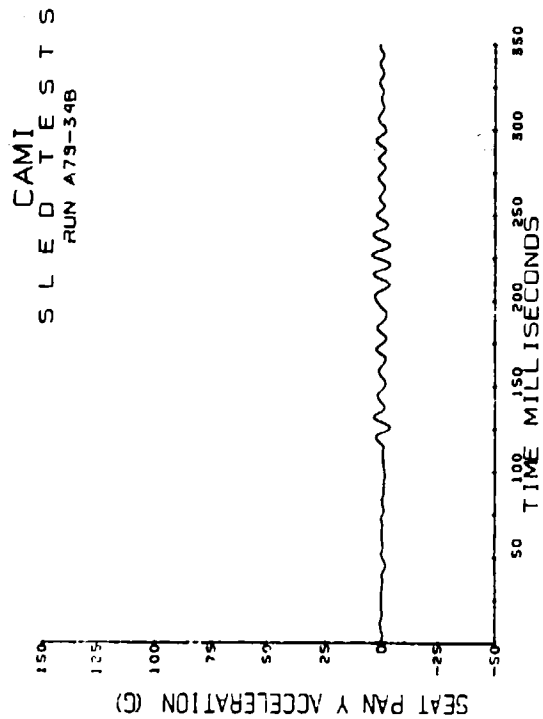
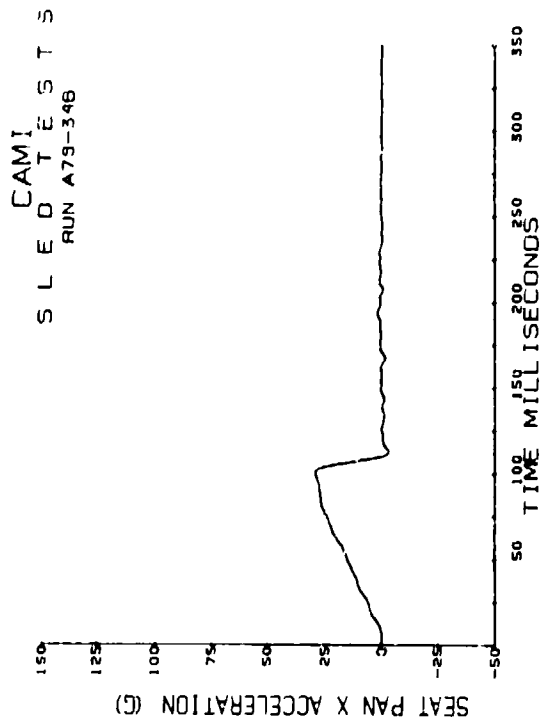


CAMI
S L E D T E S T S
RUN A79-34B

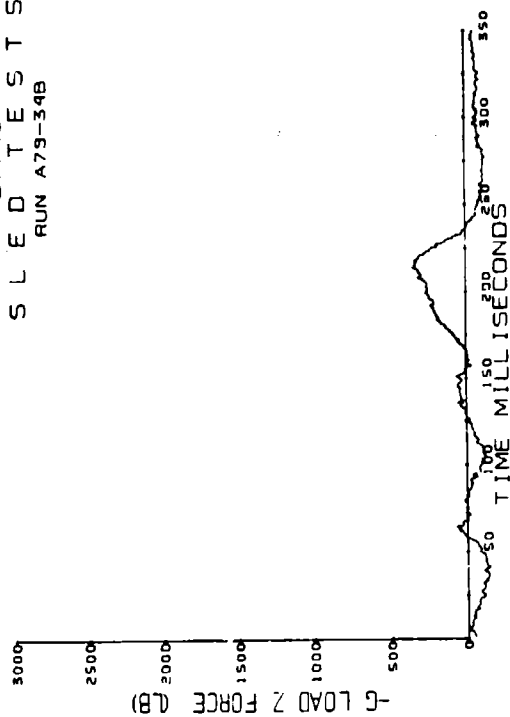


CAMI
S L E D T E S T S
RUN A79-34B

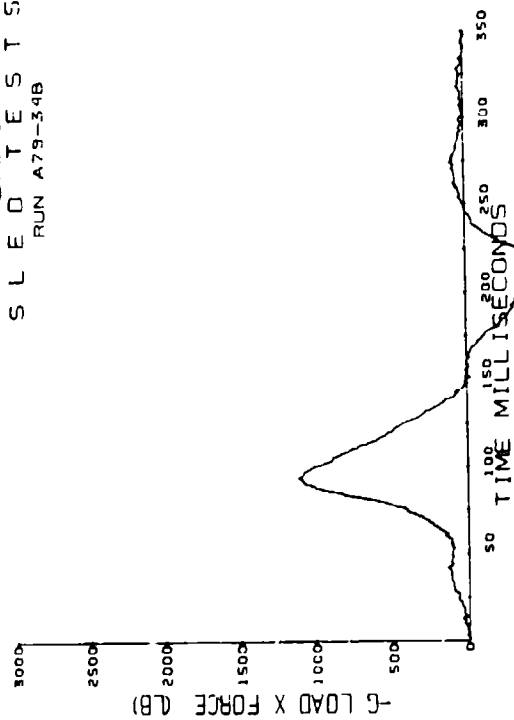




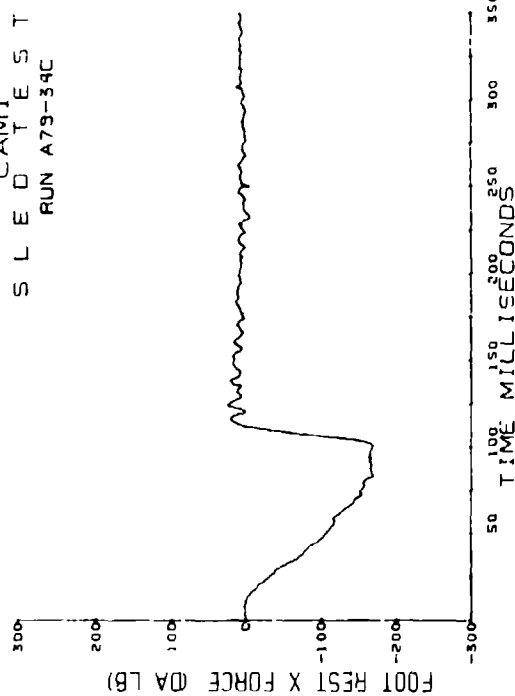
CAMI
S L E D T E S T S
RUN A79-34B



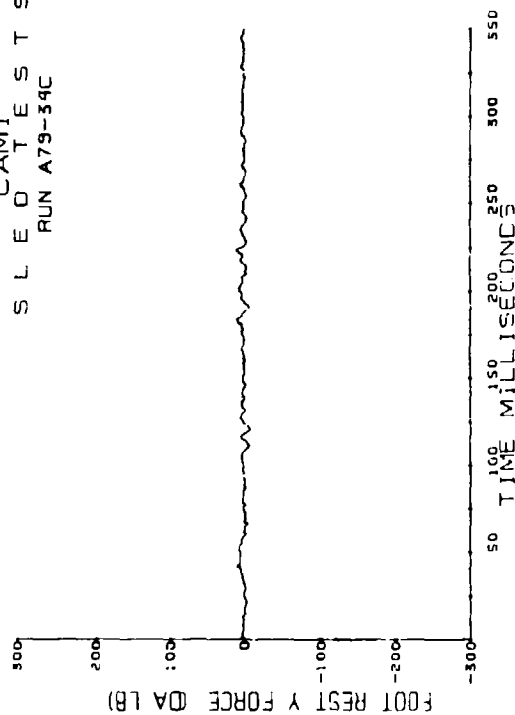
CAMI
S L E D T E S T S
RUN A79-34B



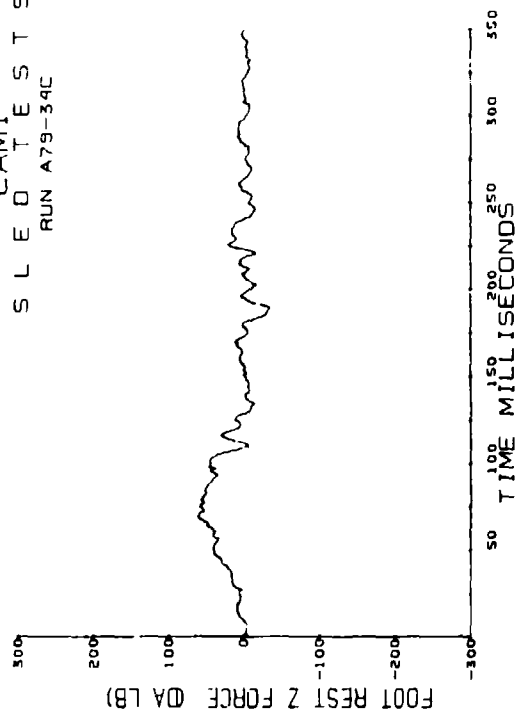
CAMI
S L E D T E S T S
RUN A79-34C



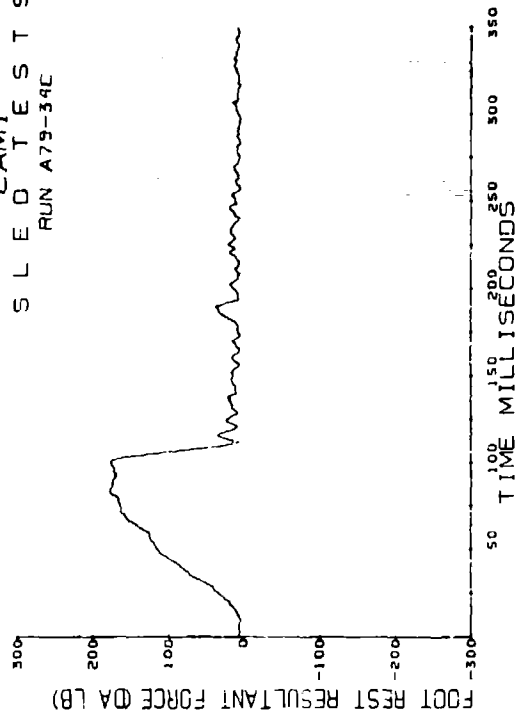
CAMI
S L E D T E S T S
RUN A79-34C

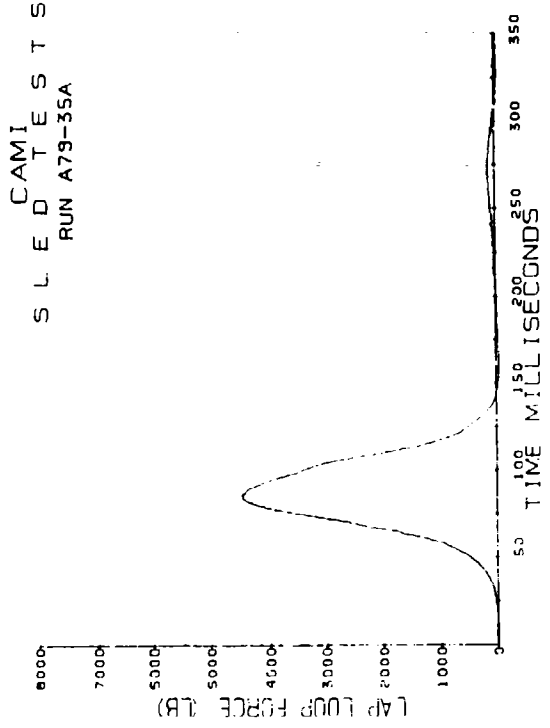
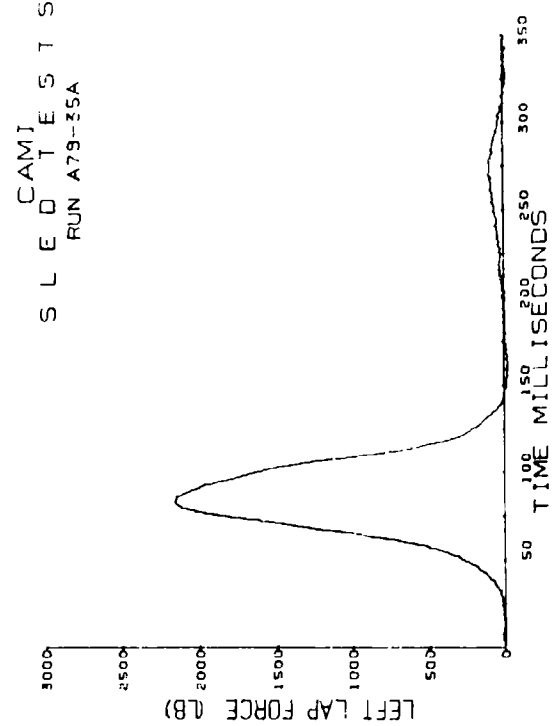
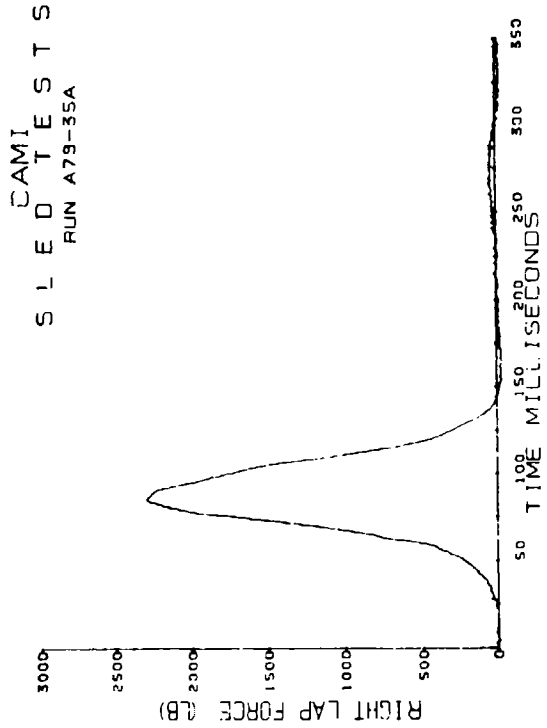
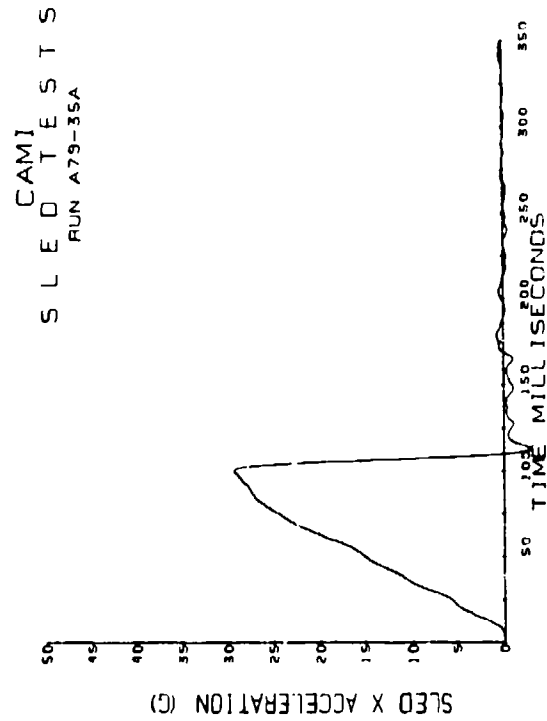


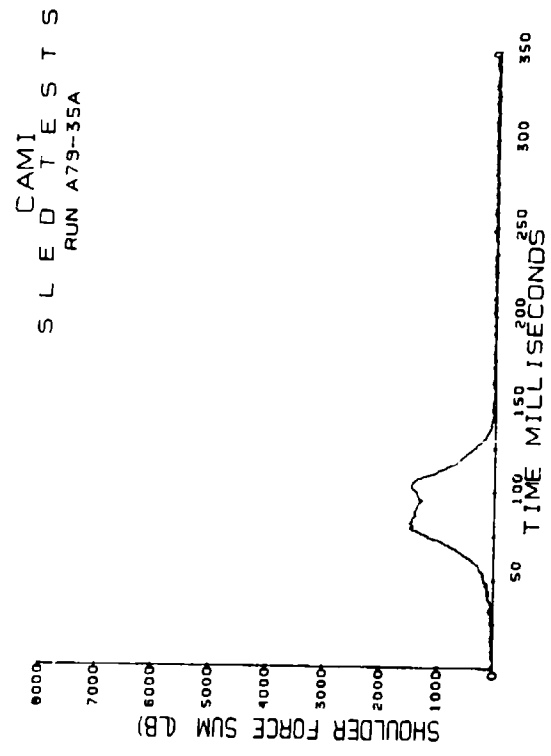
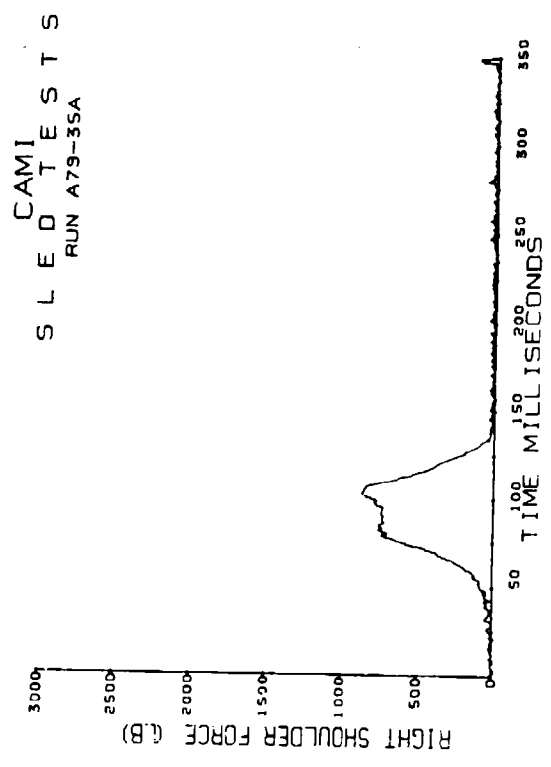
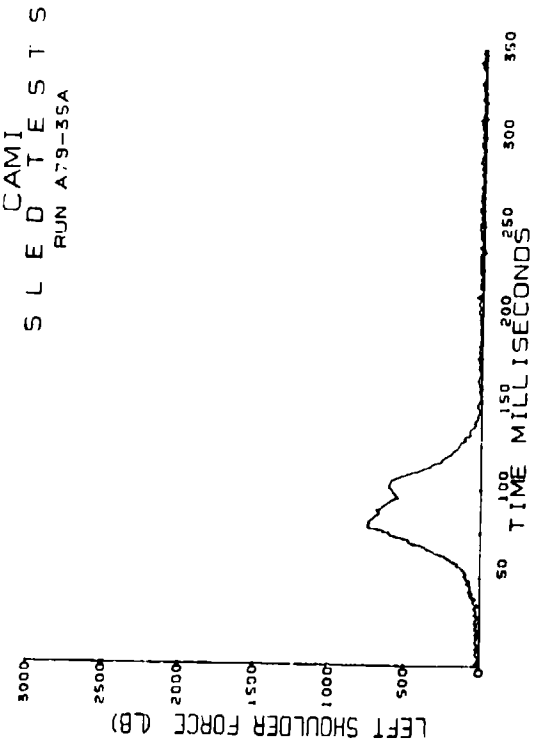
CAMI
S L E D T E S T S
RUN A79-34C

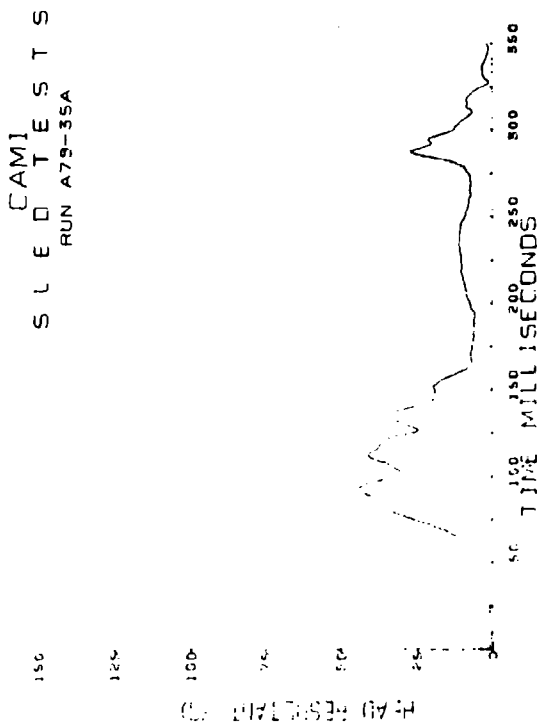
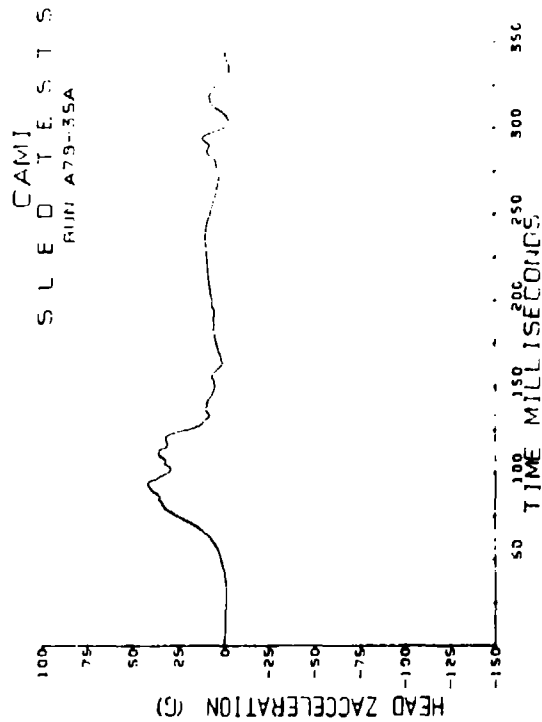
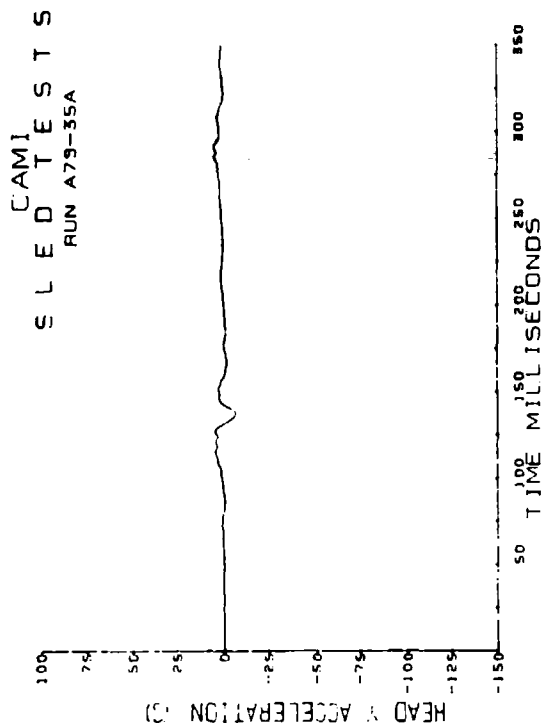
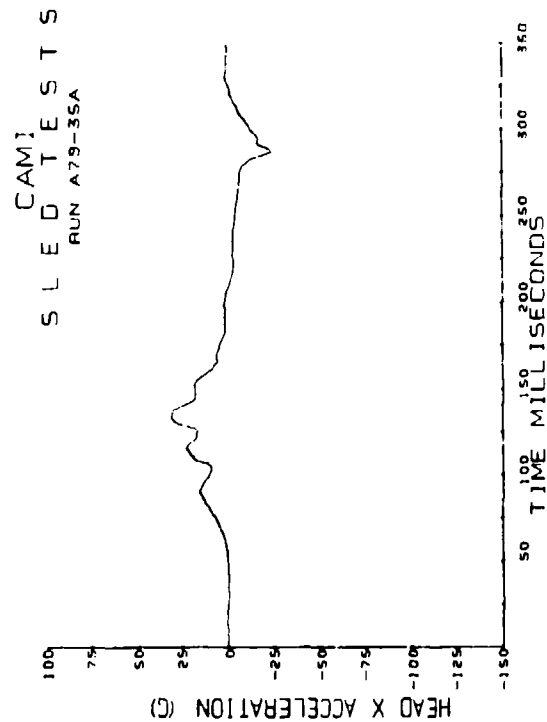


CAMI
S L E D T E S T S
RUN A79-34C

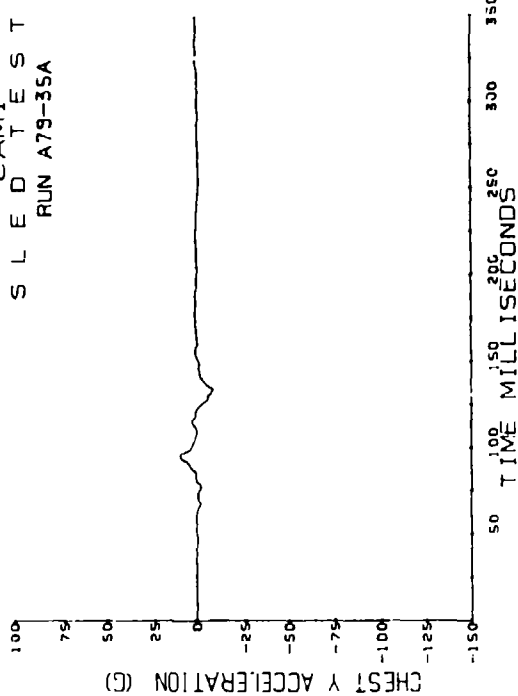




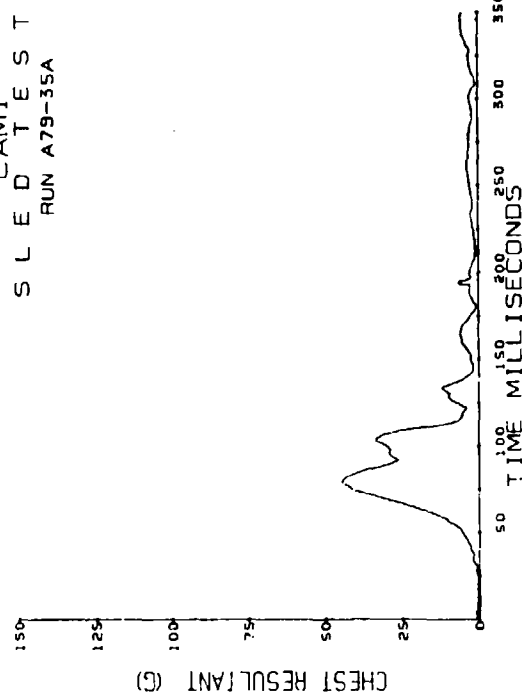




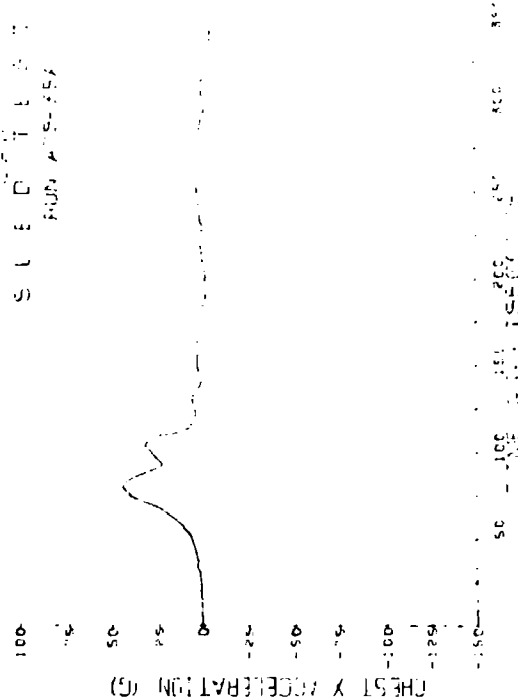
CAMI
S L E D T E S T S
RUN A79-35A



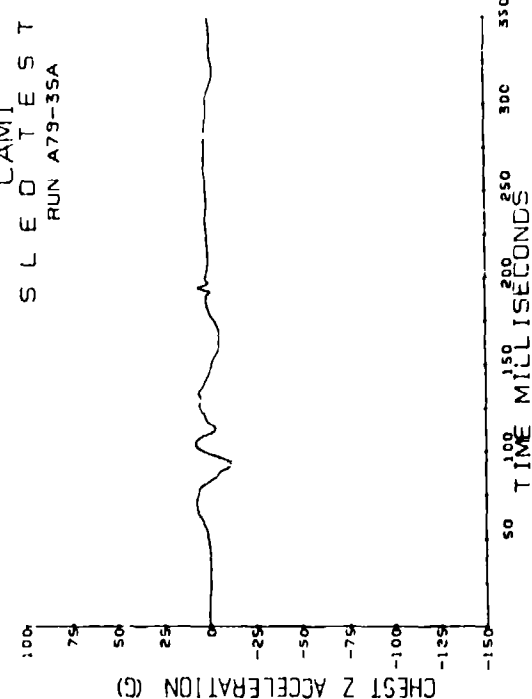
CAMI
S L E D T E S T S
RUN A79-35A

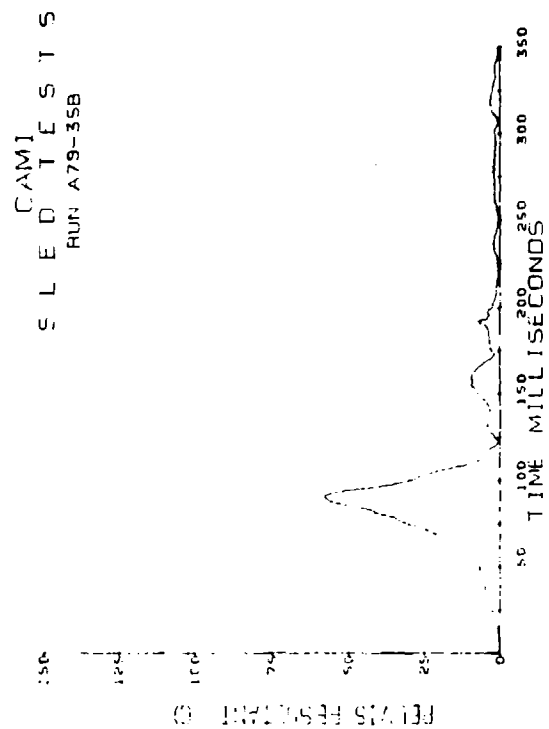
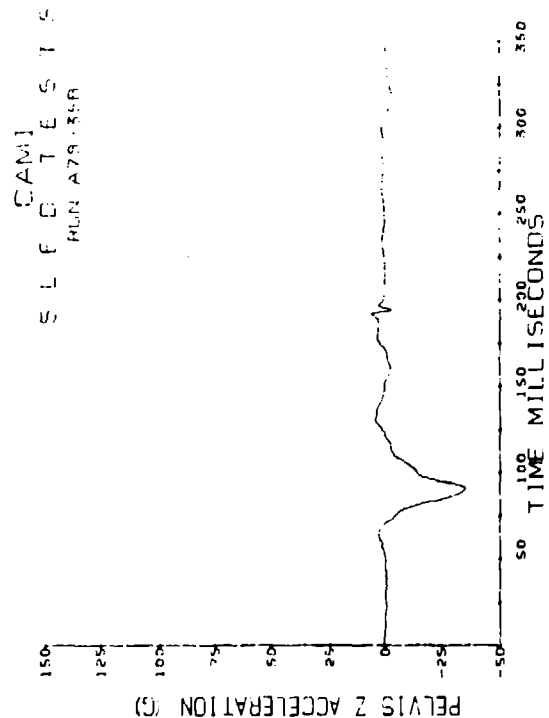
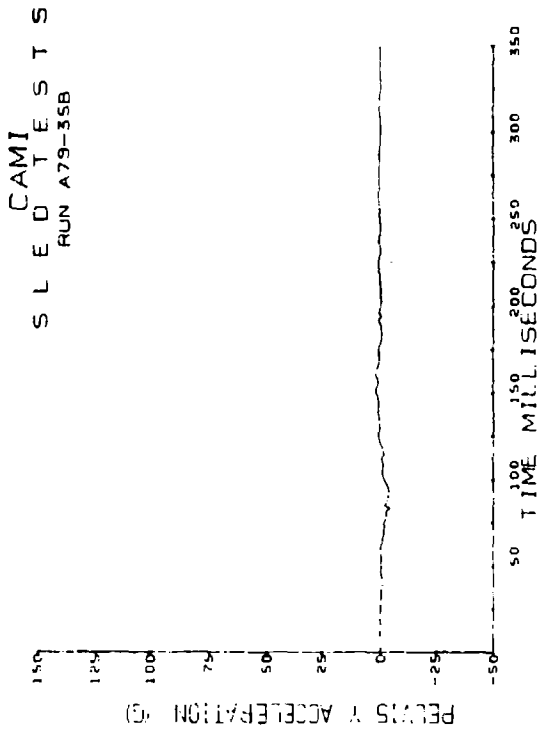
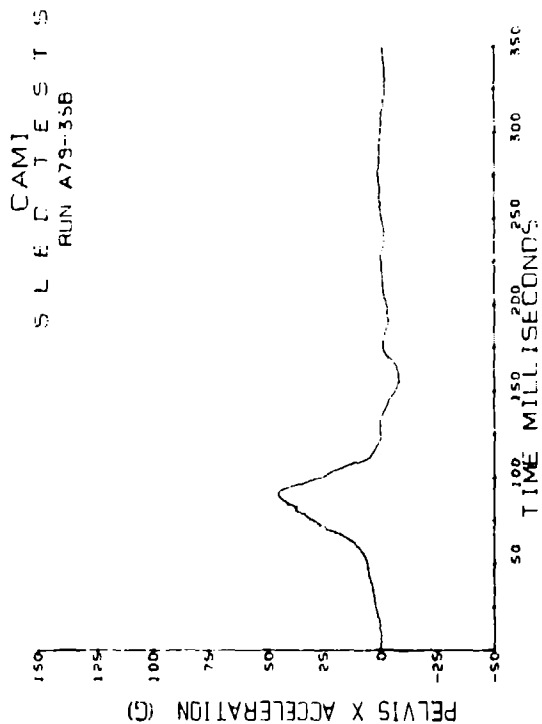


CAMI
S L E D T E S T S
RUN A79-35A

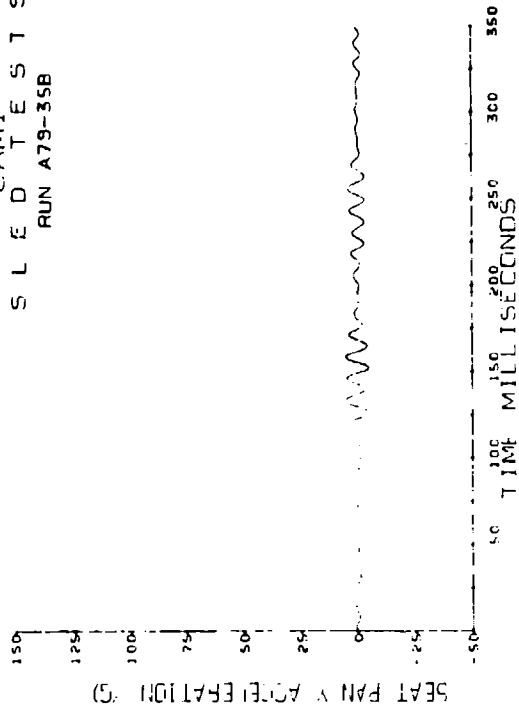


CAMI
S L E D T E S T S
RUN A79-35A

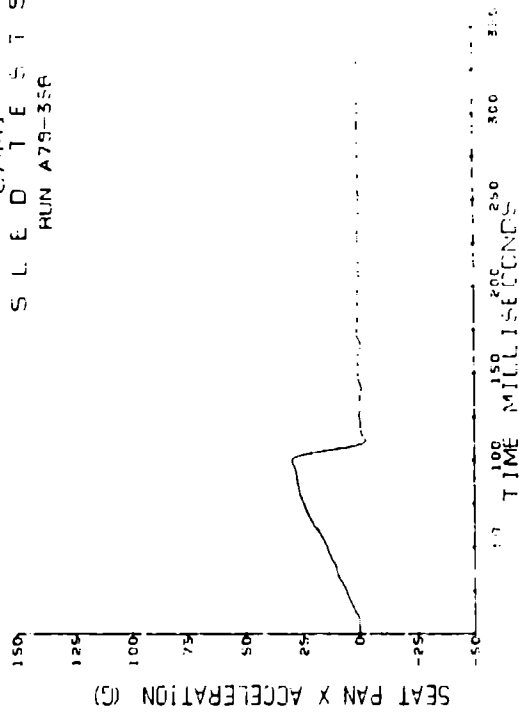




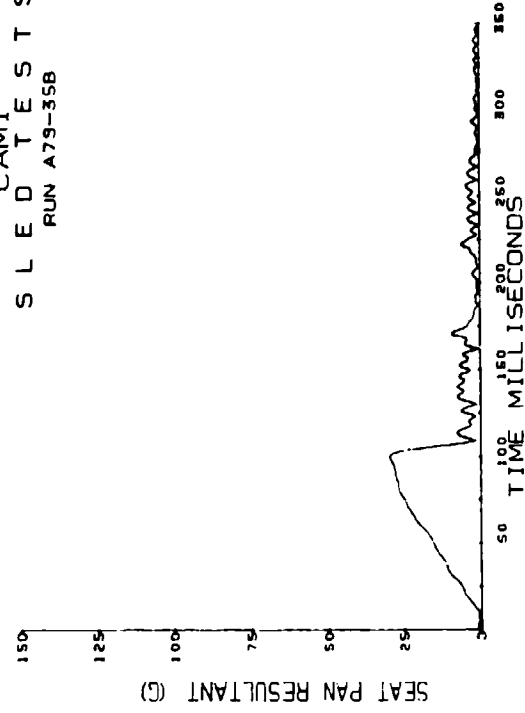
CAMI
S L E D T E S T S
RUN A79-35B



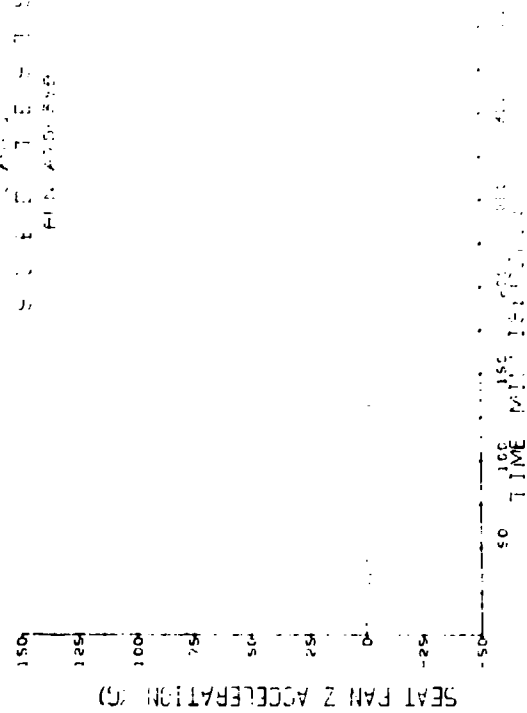
CAMI
S L E D T E S T S
RUN A79-35B



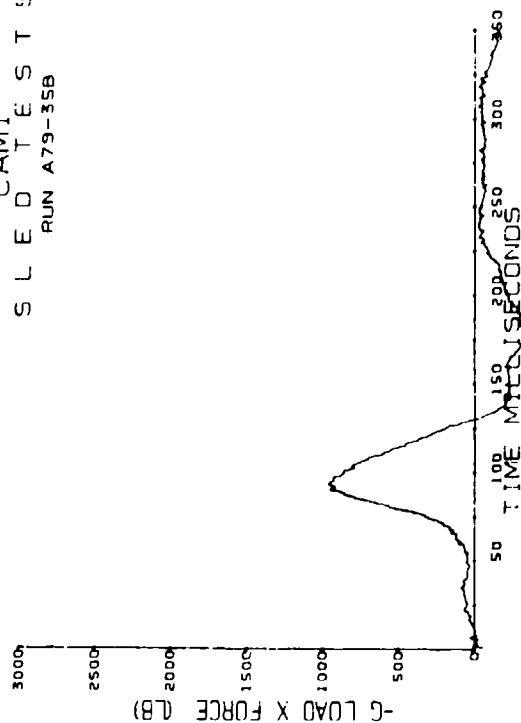
CAMI
S L E D T E S T S
RUN A79-35B



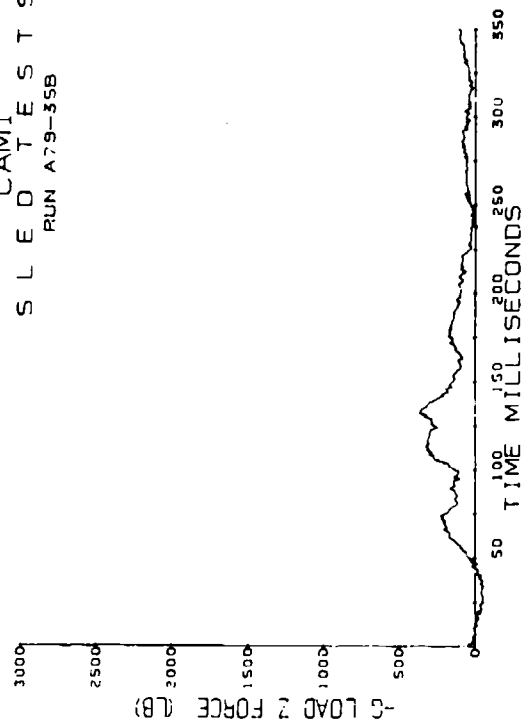
CAMI
S L E D T E S T S
RUN A79-35B

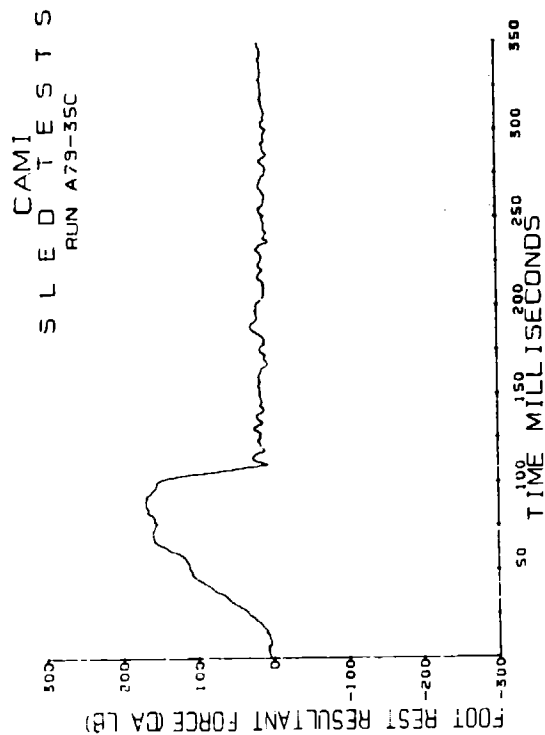
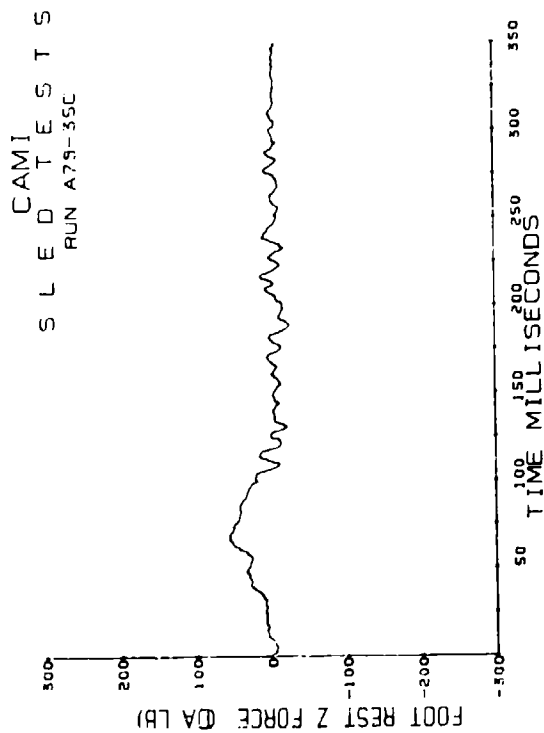
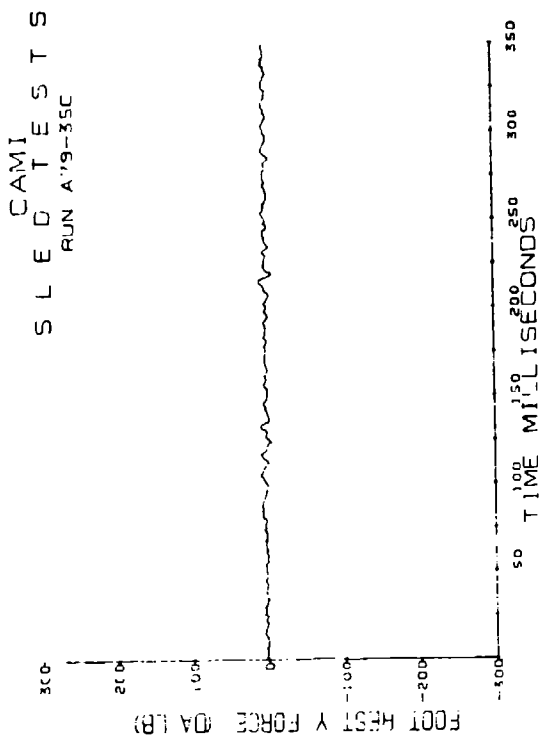
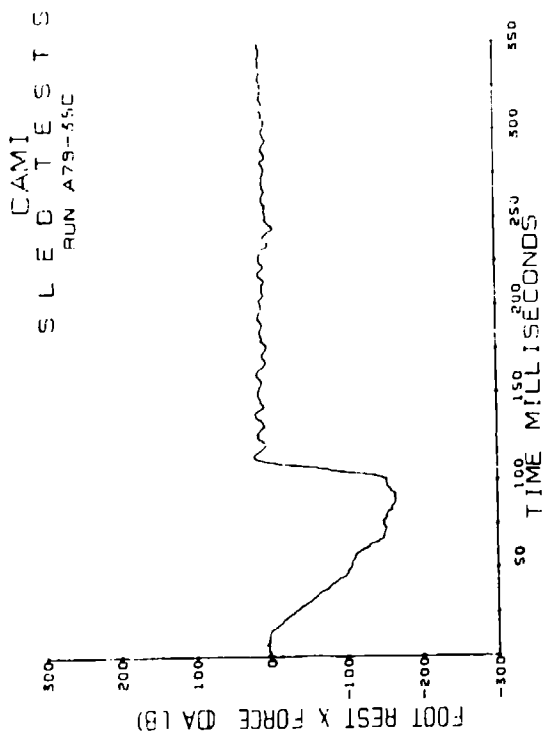


CAMI
S L E D T E S T S
RUN A79-35B

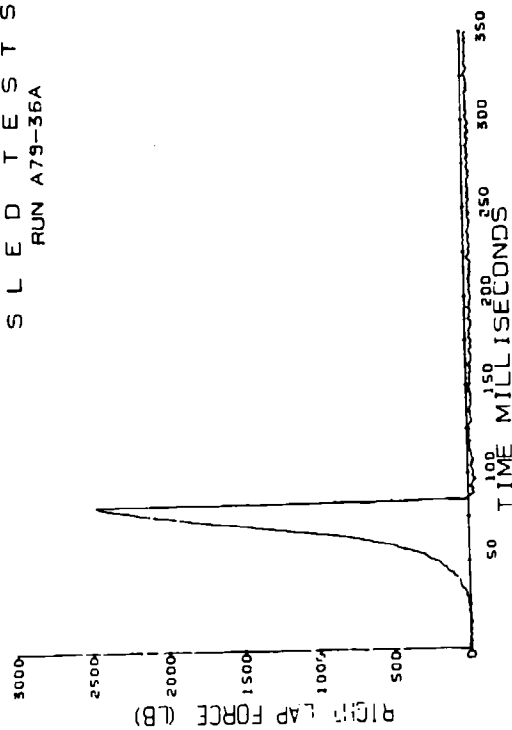


CAMI
S L E D T E S T S
RUN A79-35B

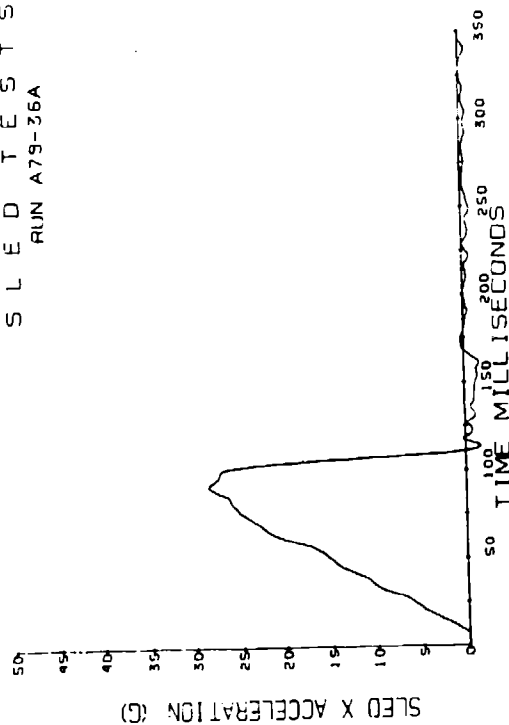




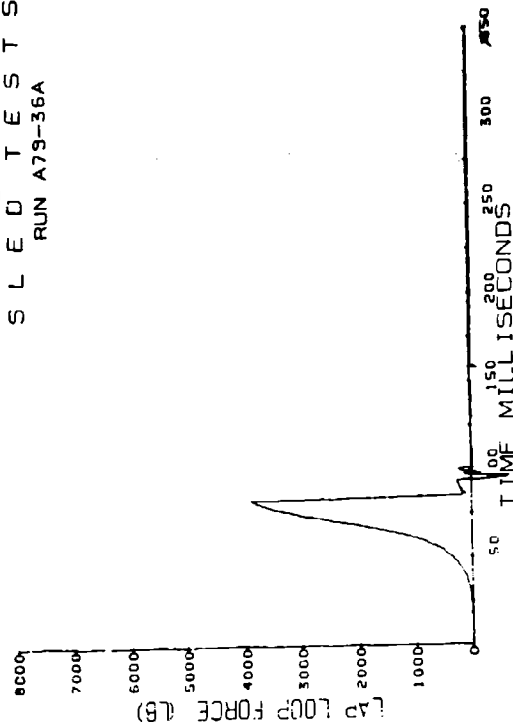
CAMI
S L E D T E S T S
RUN A79-36A



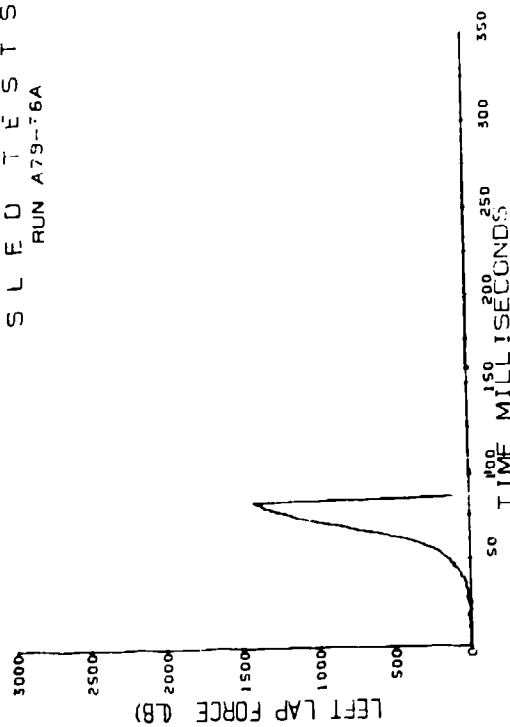
CAMI
S L E D T E S T S
RUN A79-36A



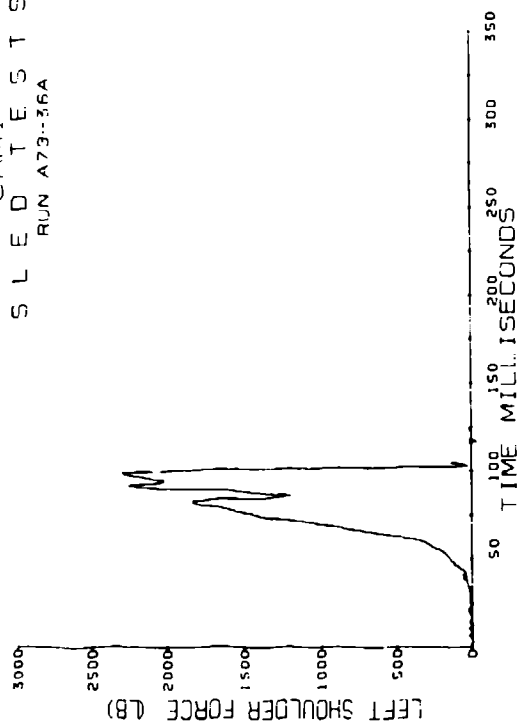
CAMI
S L E D T E S T S
RUN A79-36A



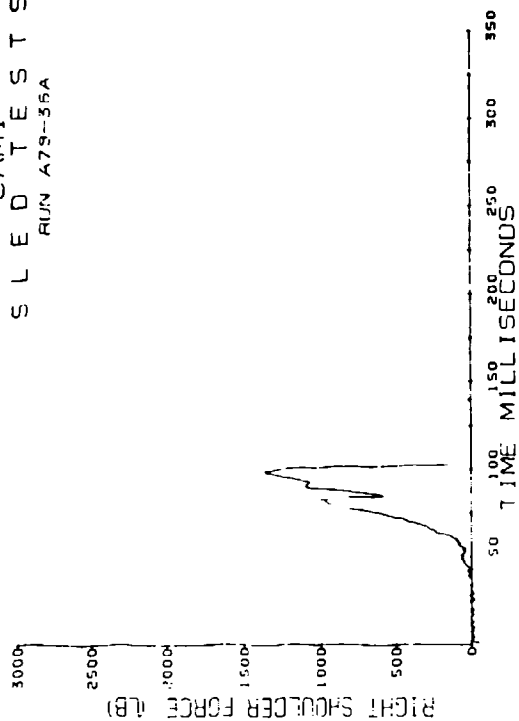
CAMI
S L E D T E S T S
RUN A79-36A



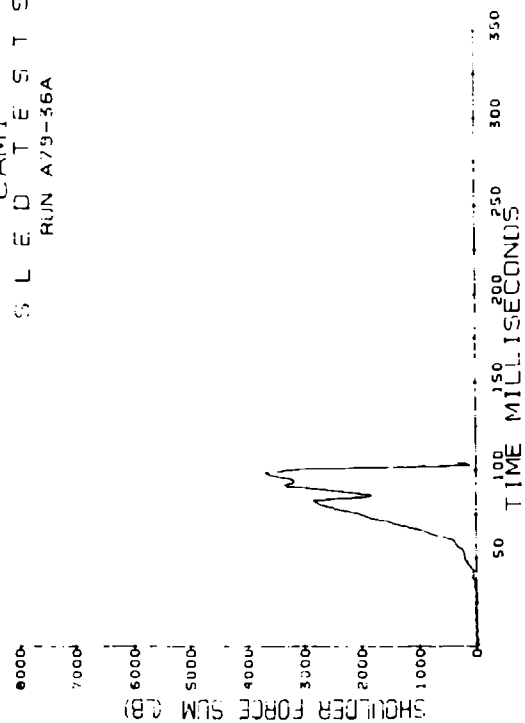
CAMI
S L E D T E S T S
RUN A73-36A



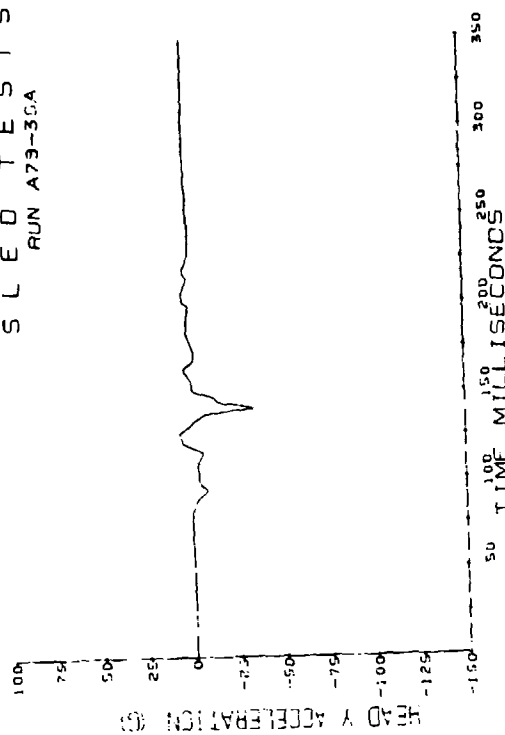
CAMI
S L E D T E S T S
RUN A79-36A



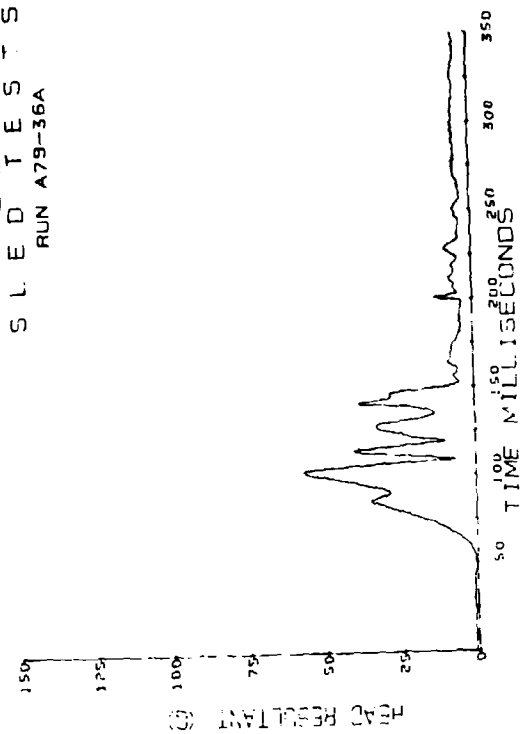
CAMI
S L E D T E S T S
RUN A79-36A



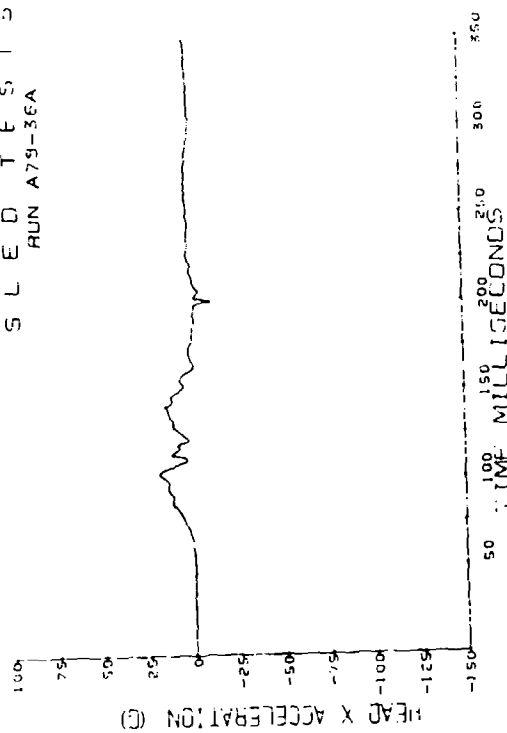
CAMI
S L E D T E S T S
RUN A79-36A



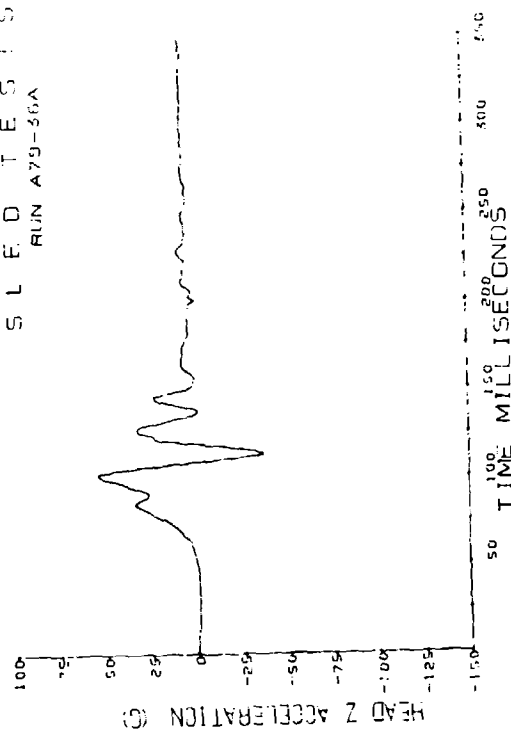
CAMI
S L E D T E S T S
RUN A79-36A

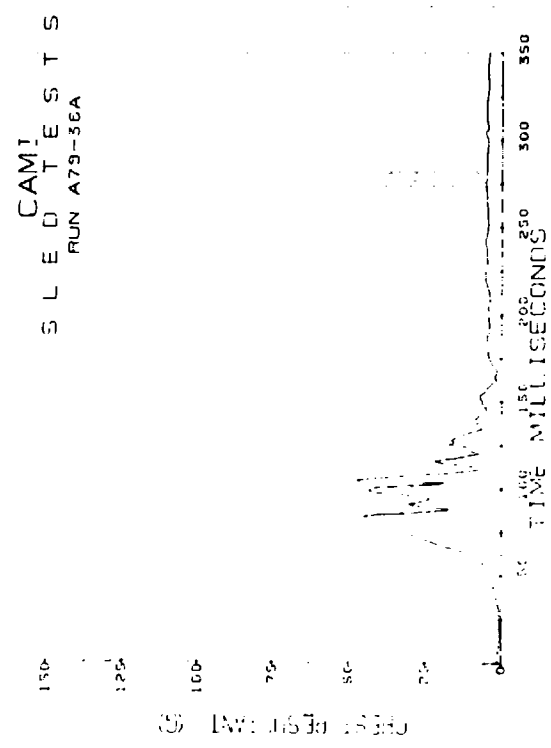
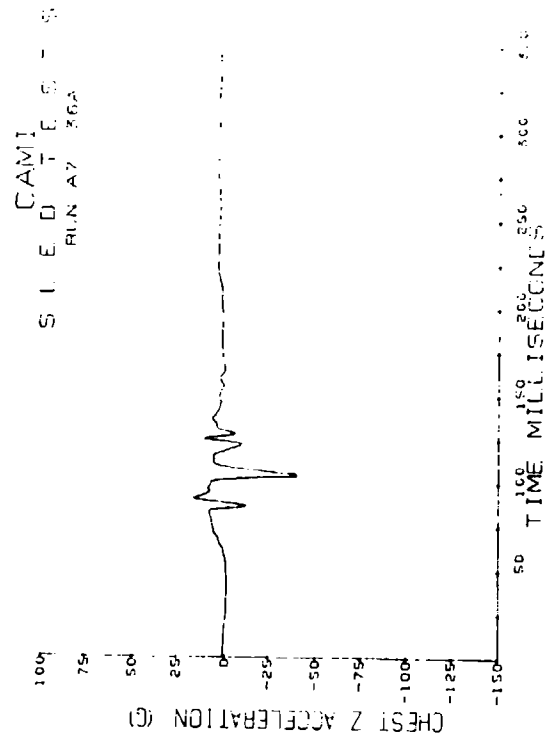
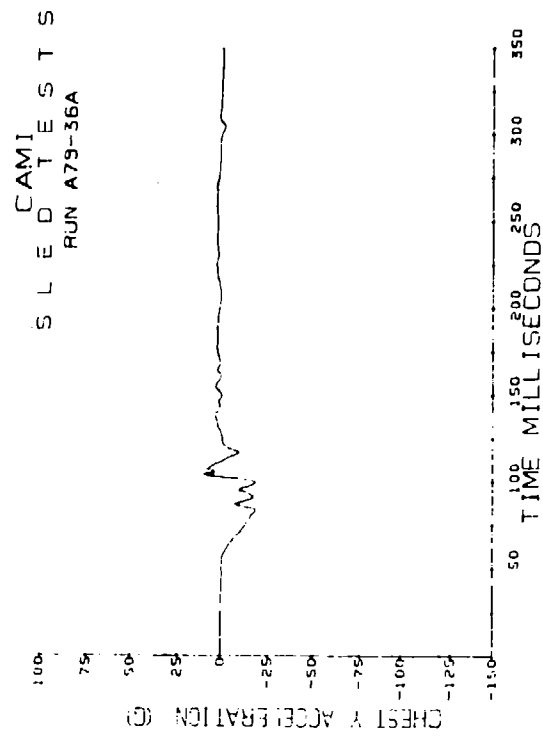
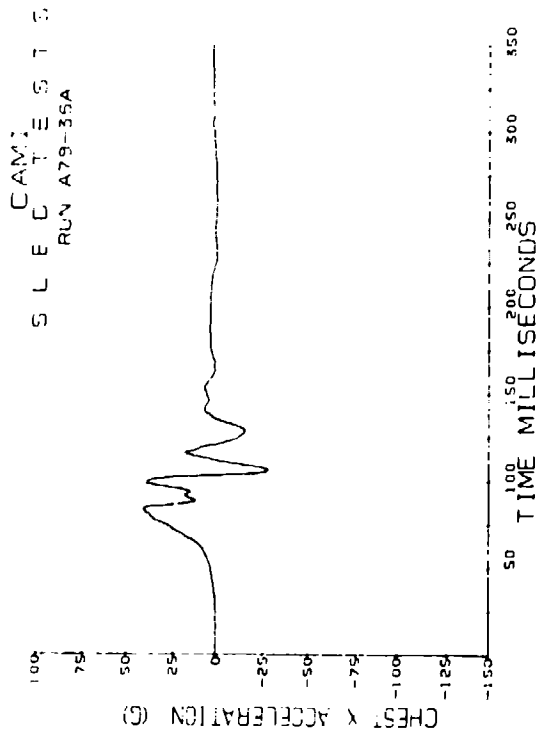


CAMI
S L E D T E S T S
RUN A79-36A

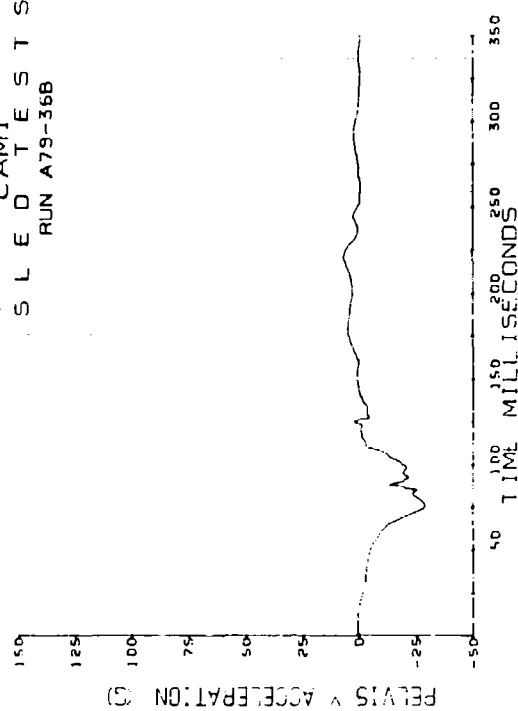


CAMI
S L E D T E S T S
RUN A79-36A

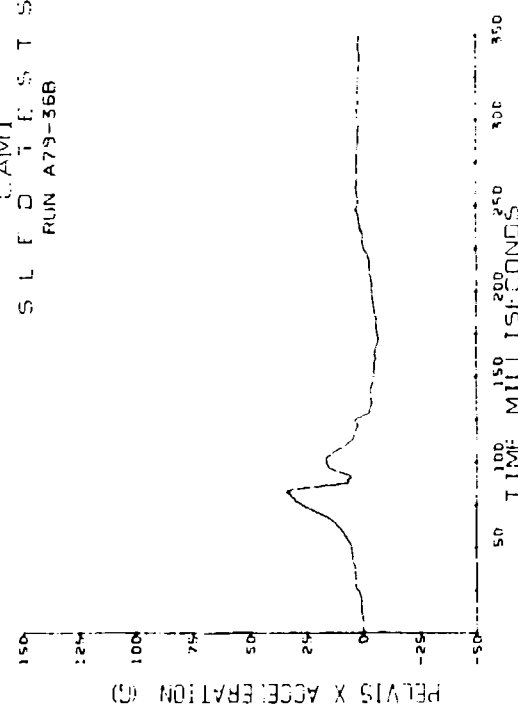




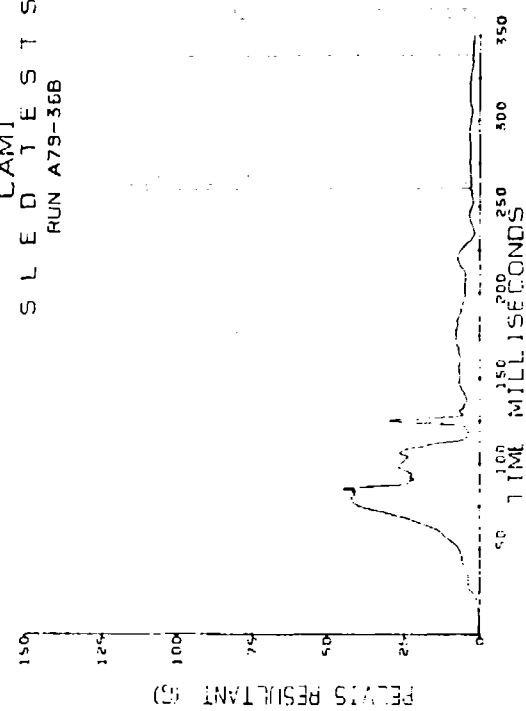
CAMI
S L E D T E S T S
RUN A79-36B



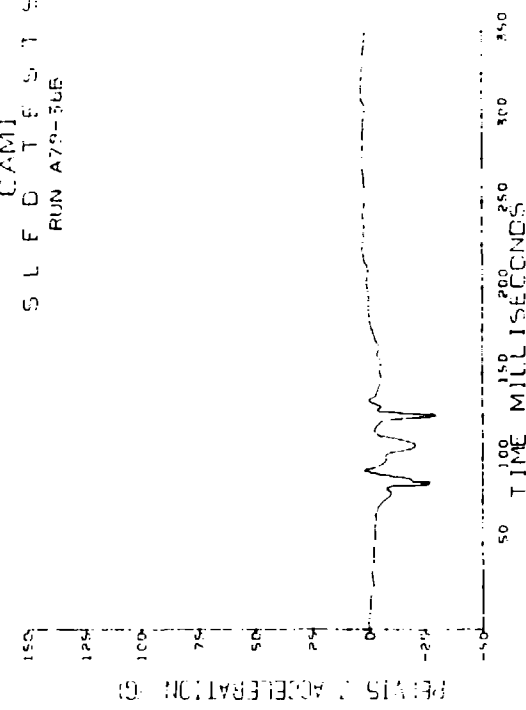
CAMI
S L E D T E S T S
RUN A79-36B



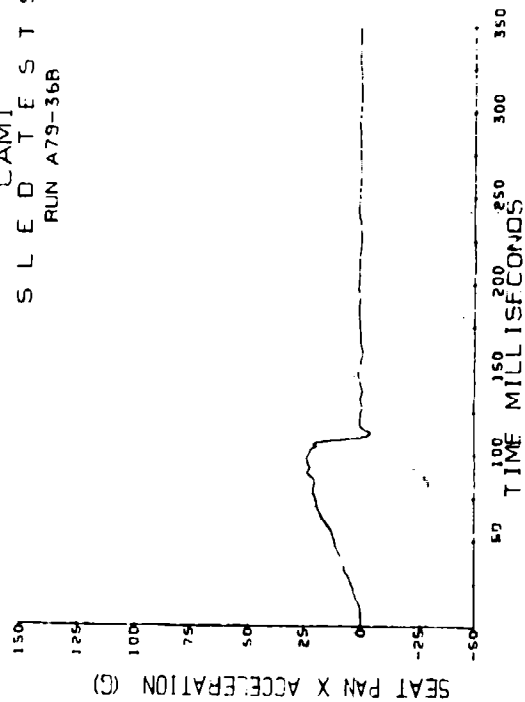
CAMI
S L E D T E S T S
RUN A79-36B



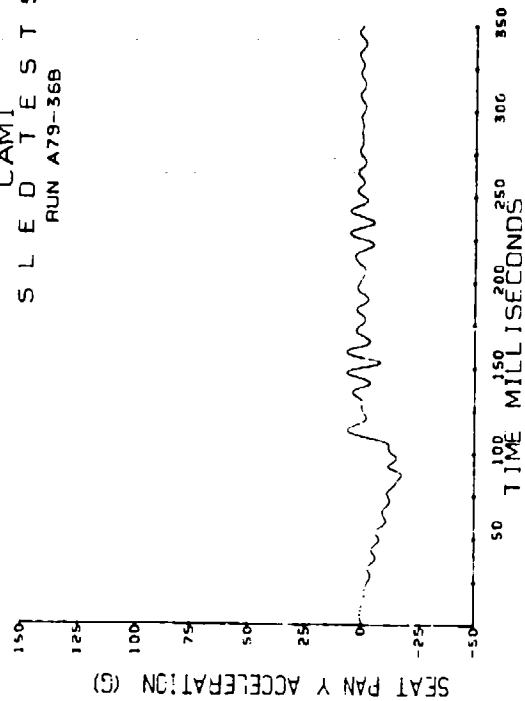
CAMI
S L E D T E S T S
RUN A79-36B



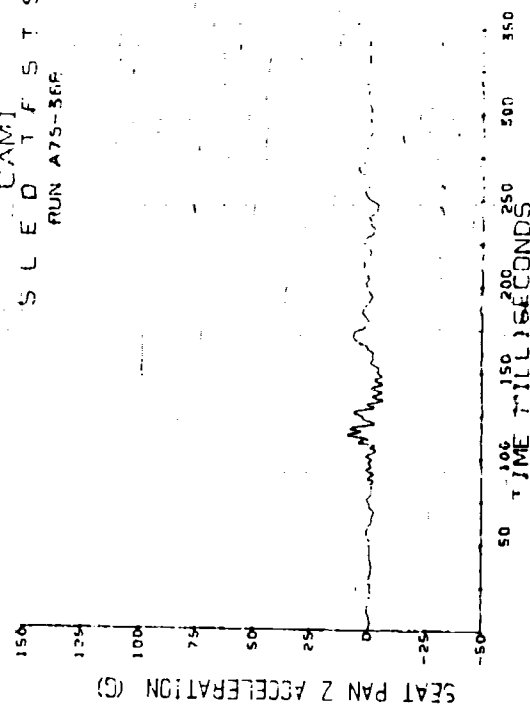
CAMI
S L E D T E S T S
RUN A79-36B



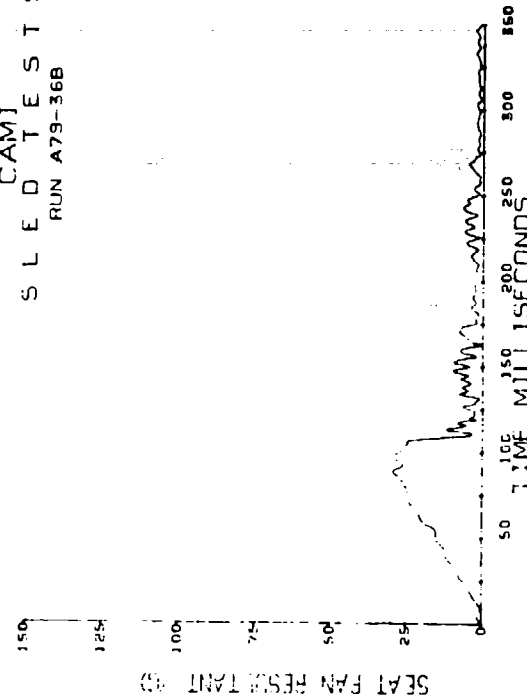
CAMI
S L E D T E S T S
RUN A79-36B



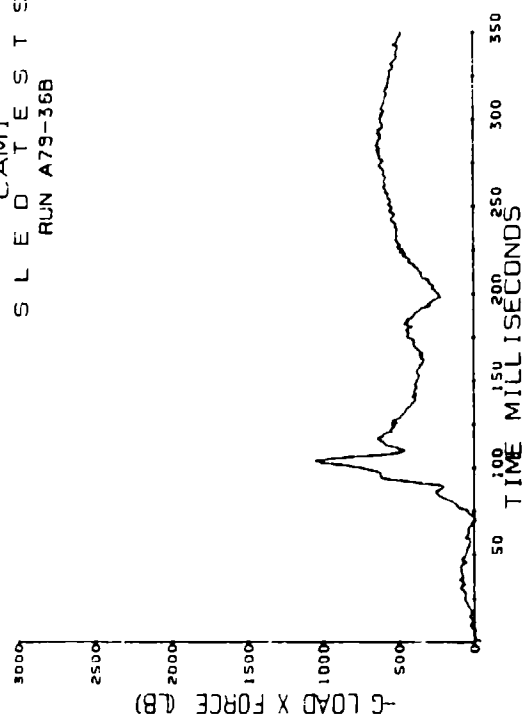
CAMI
S L E D T E S T S
RUN A75-36B



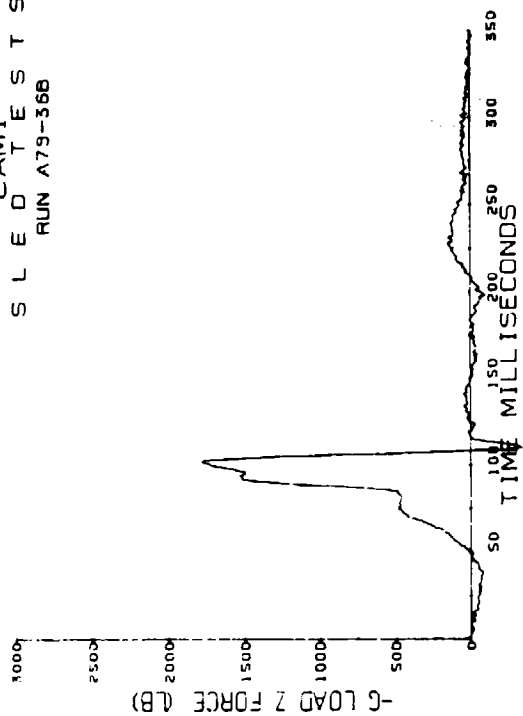
CAMI
S L E D T E S T S
RUN A79-36B

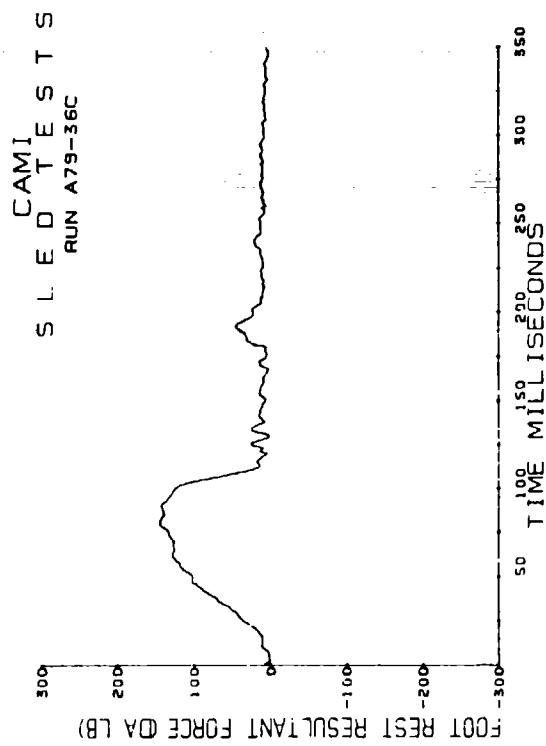
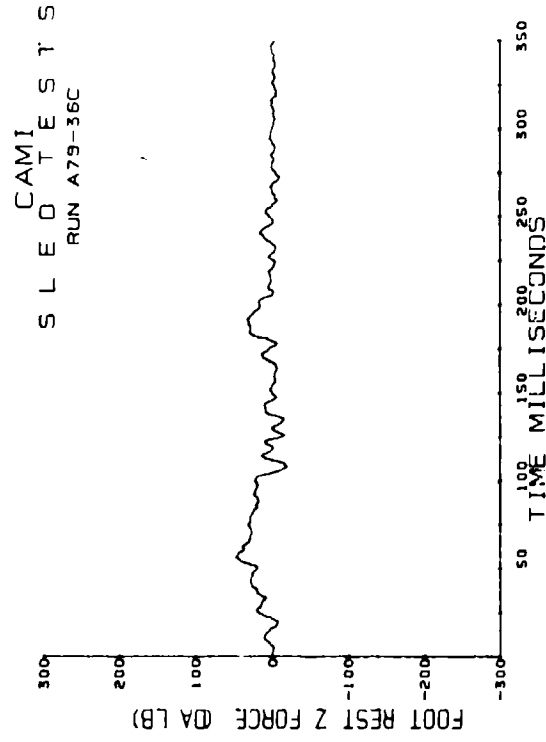
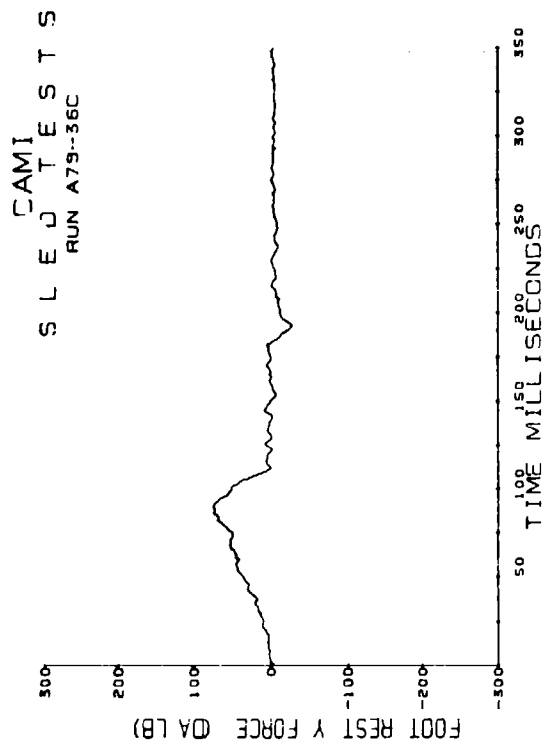
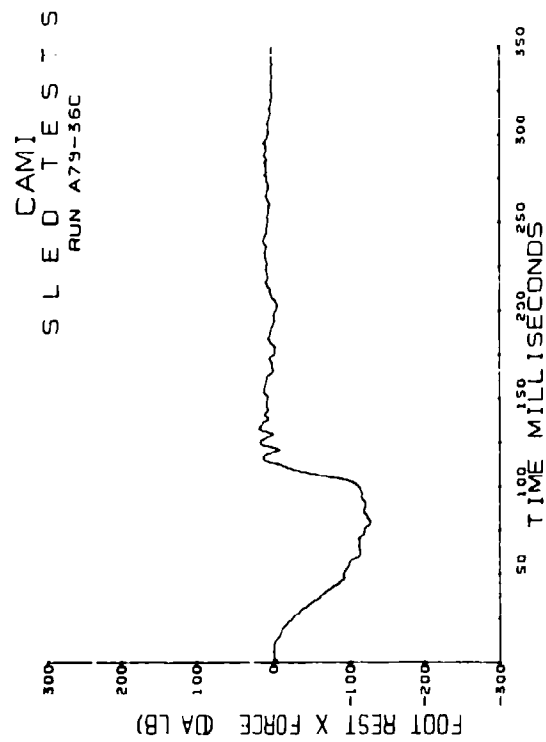


CAMI
S L E D T E S T S
RUN A79-368

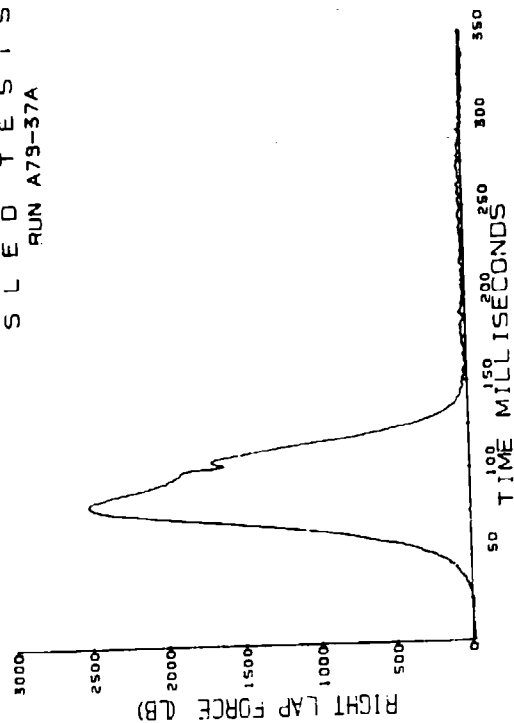


CAMI
S L E D T E S T S
RUN A79-368

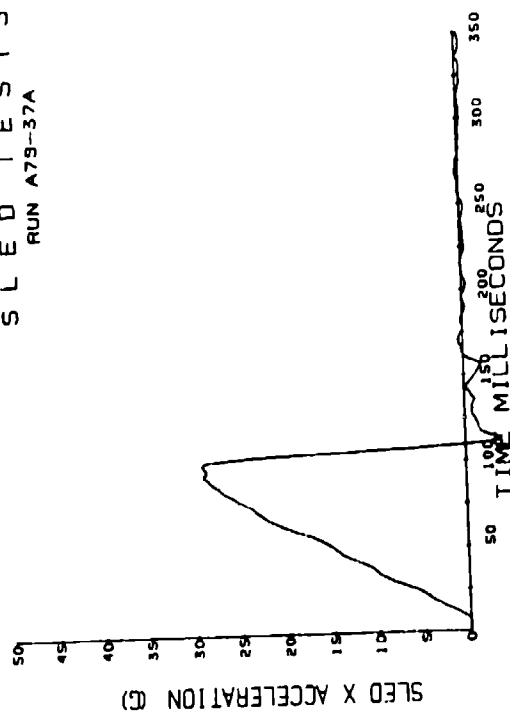




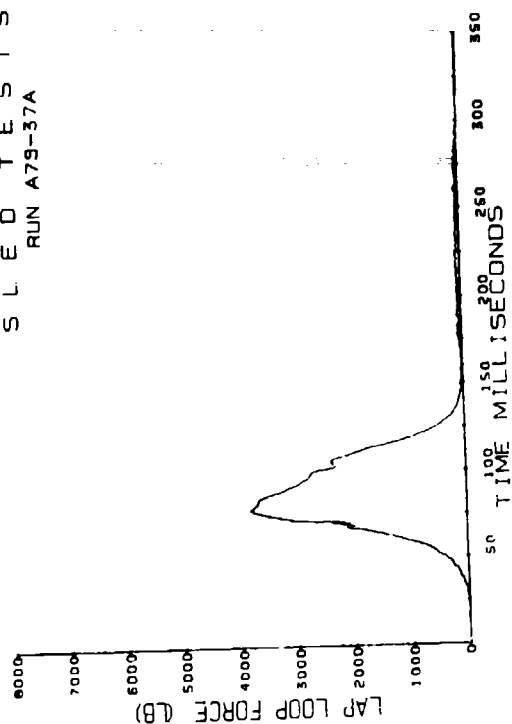
CAMI
S L E D T E S T S
RUN A79-37A



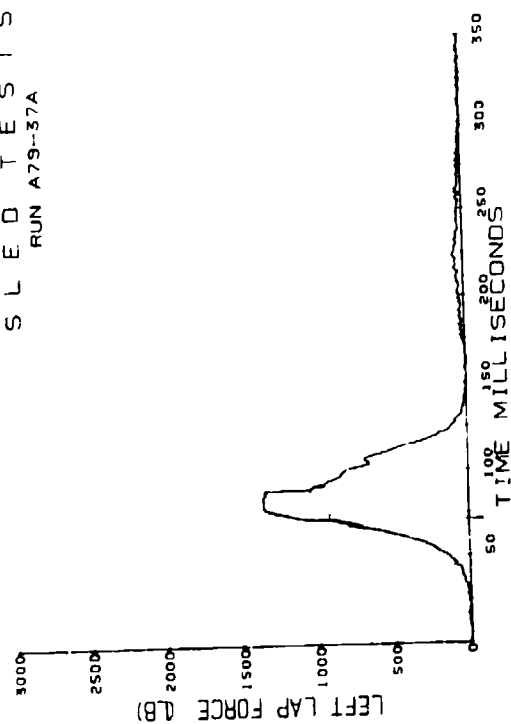
CAMI
S L E D T E S T S
RUN A79-37A



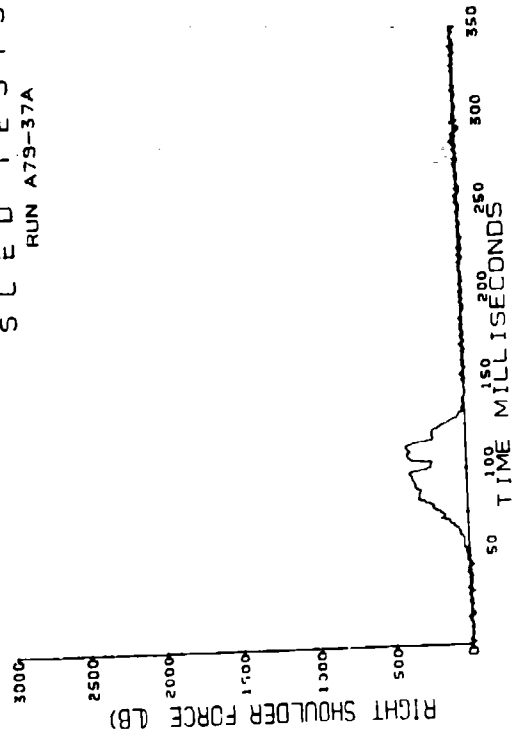
CAMI
S L E D T E S T S
RUN A79-37A



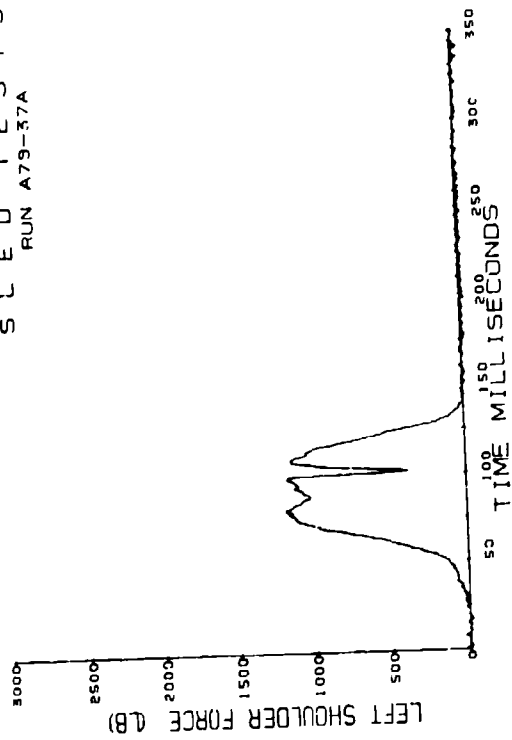
CAMI
S L E D T E S T S
RUN A79-37A



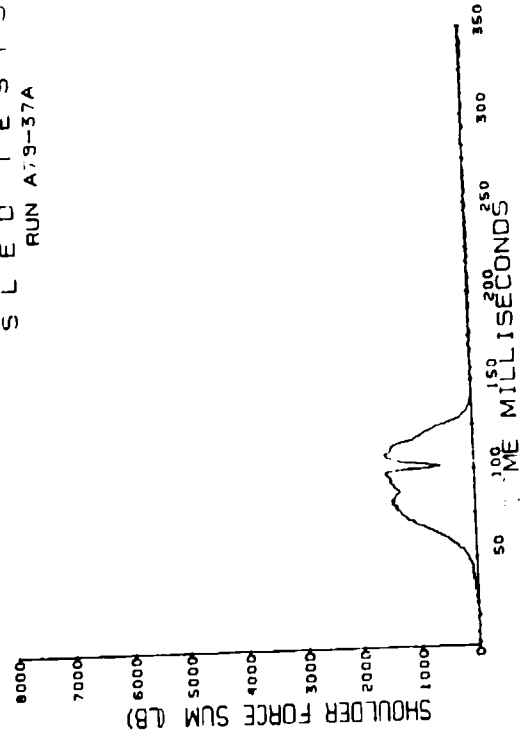
CAMI
S L E D T E S T S
RUN A79-37A

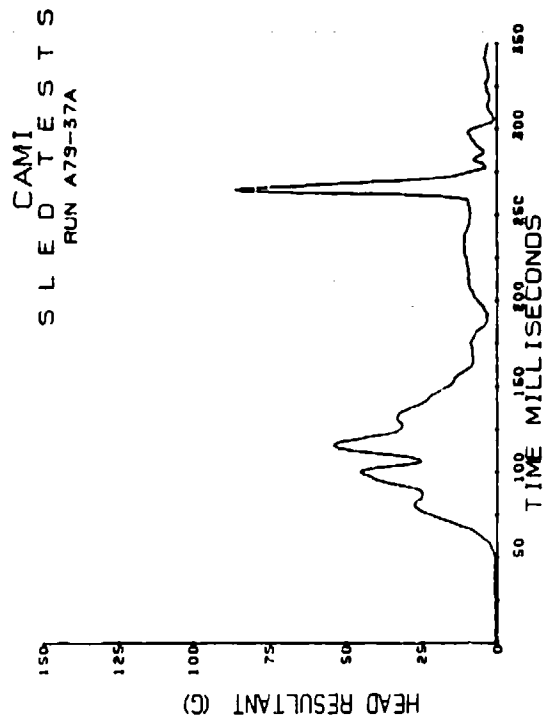
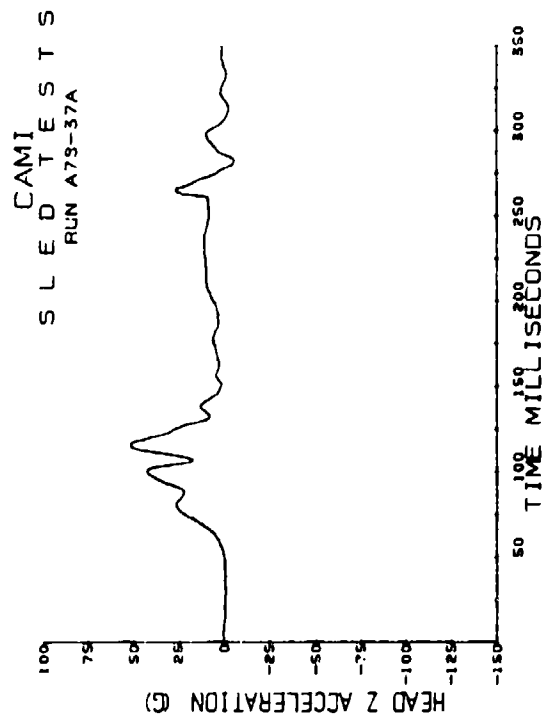
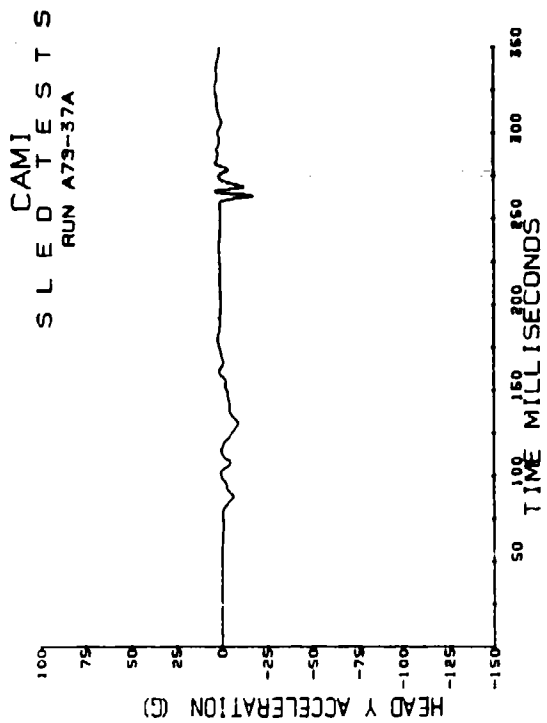
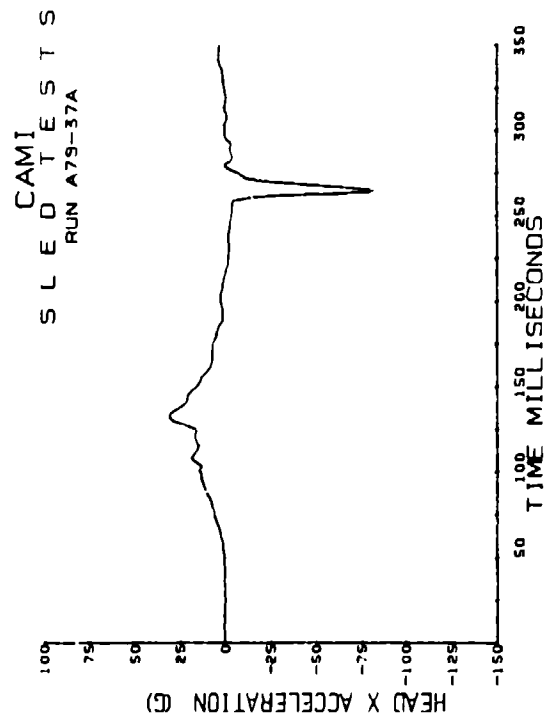


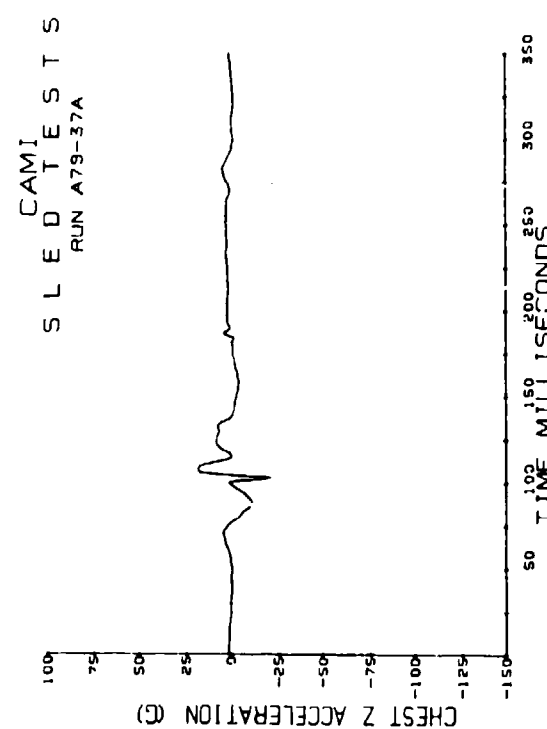
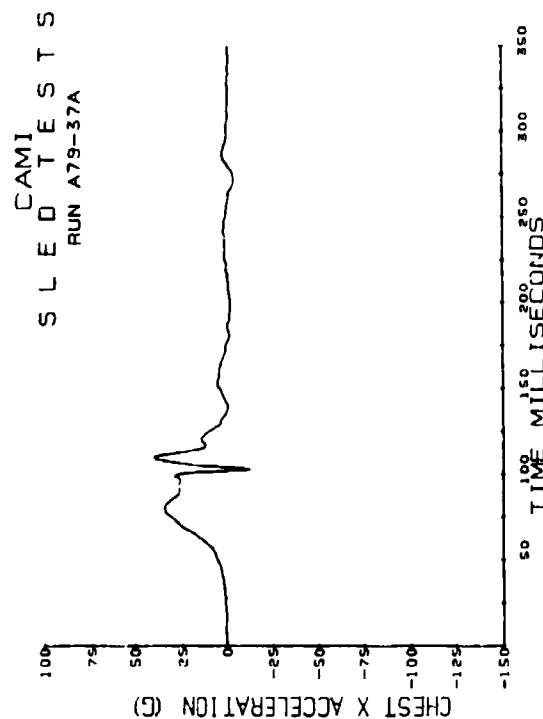
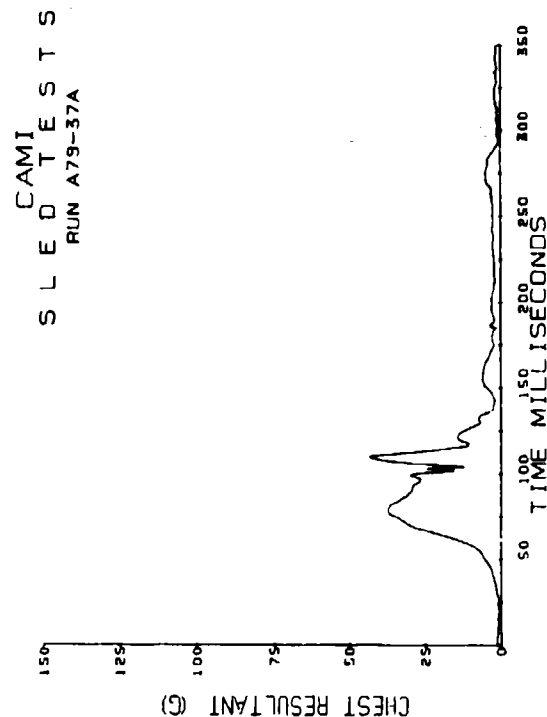
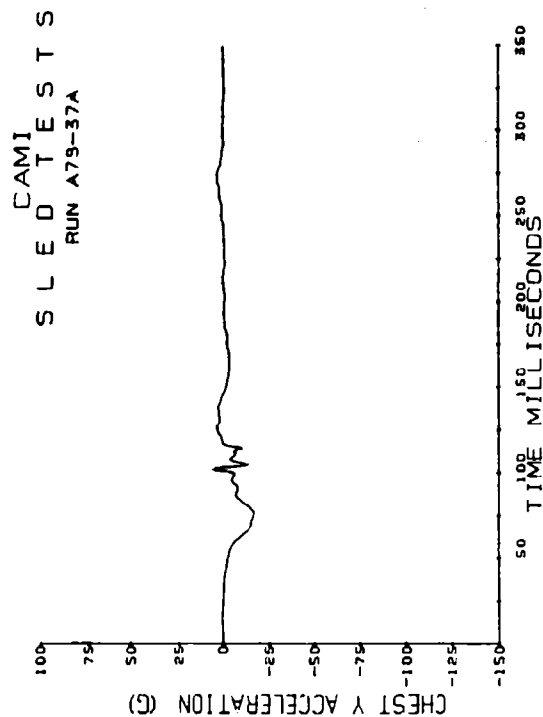
CAMI
S L E D T E S T S
RUN A79-37A



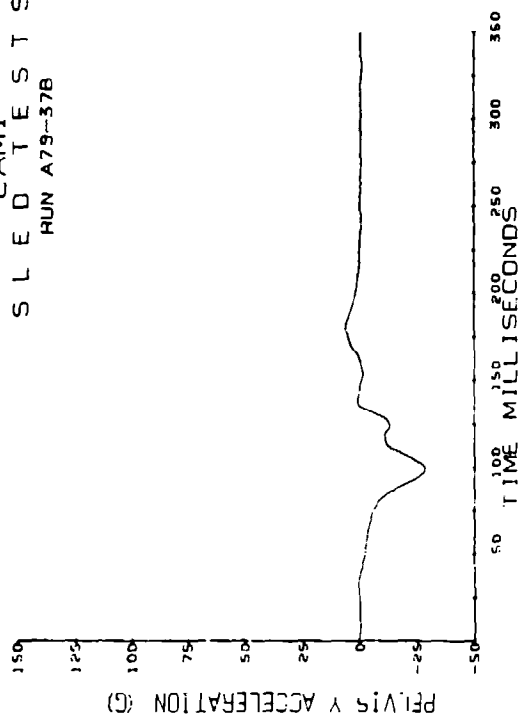
CAMI
S L E D T E S T S
RUN A79-37A



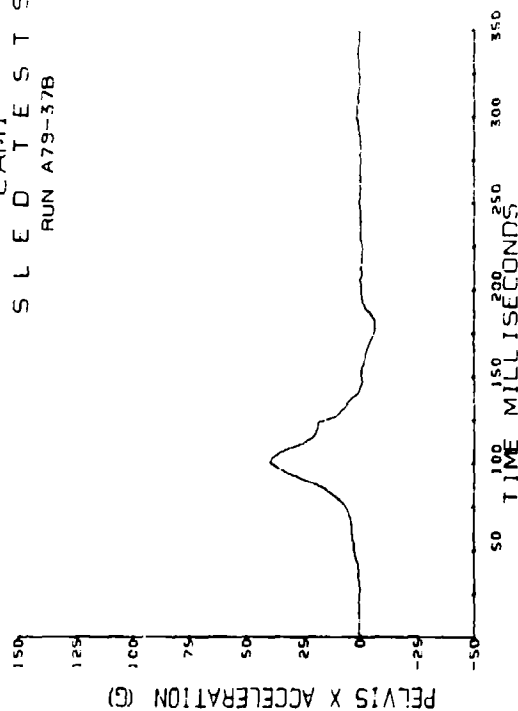




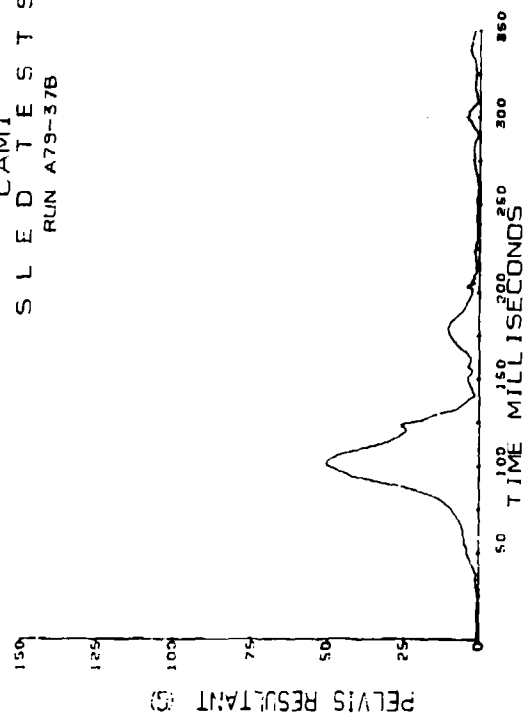
CAMI
S L E D T E S T S
RUN A79-37B



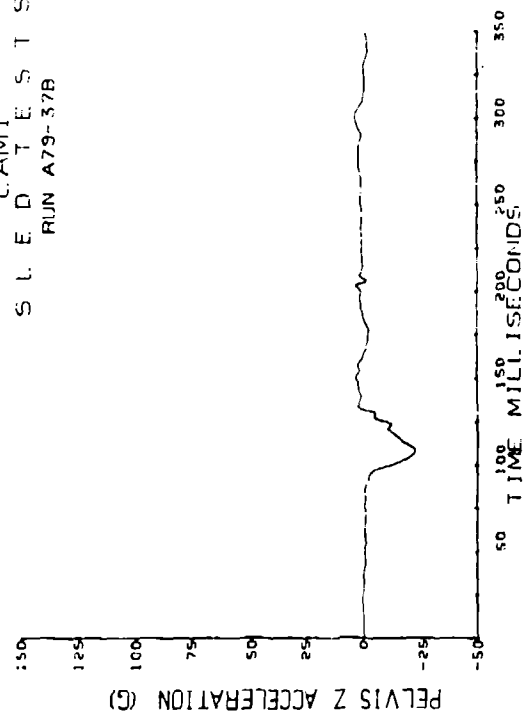
CAMI
S L E D T E S T S
RUN A79-37B

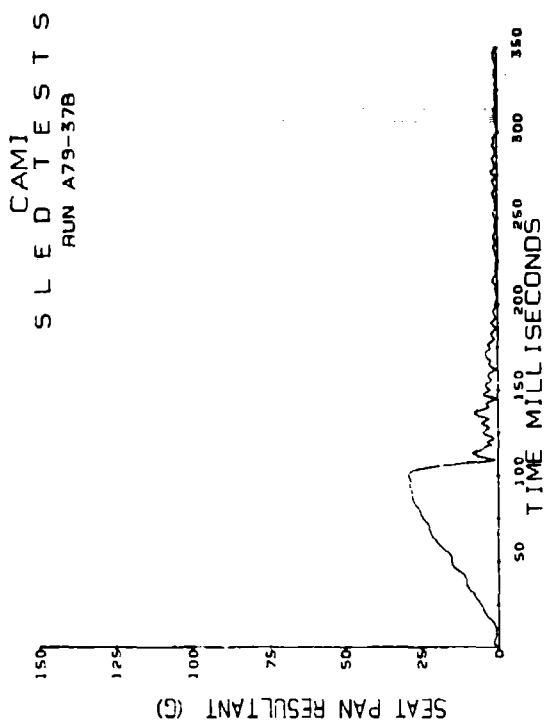
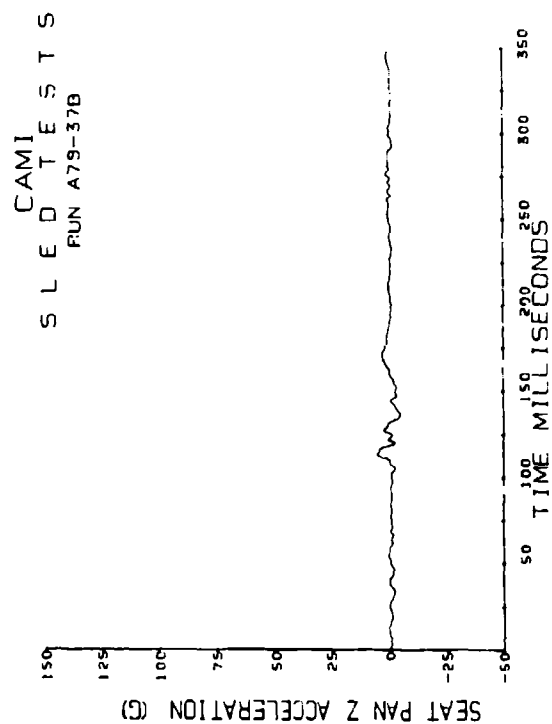
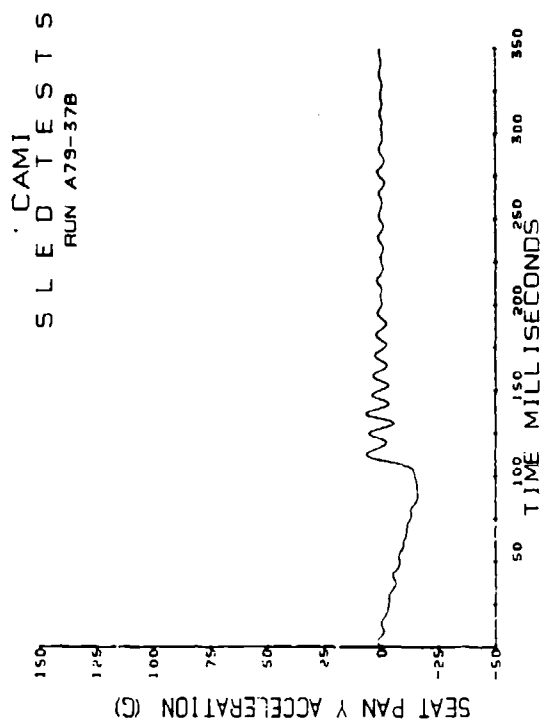
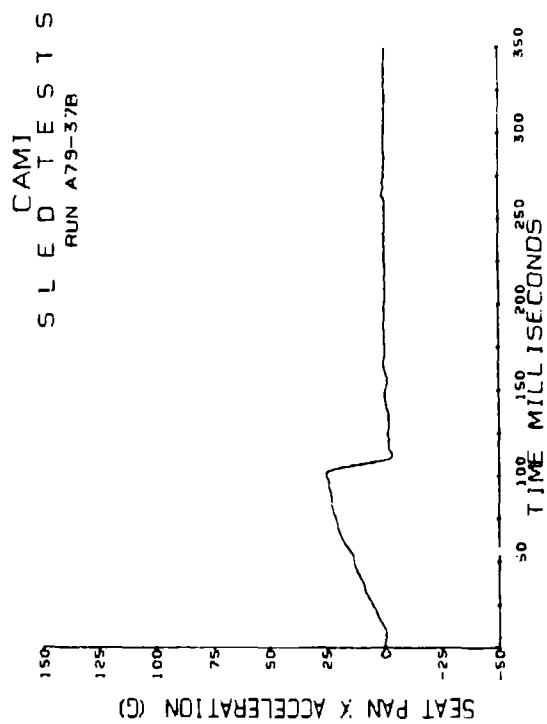


CAMI
S L E D T E S T S
RUN A79-37B



CAMI
S L E D T E S T S
RUN A79-37B





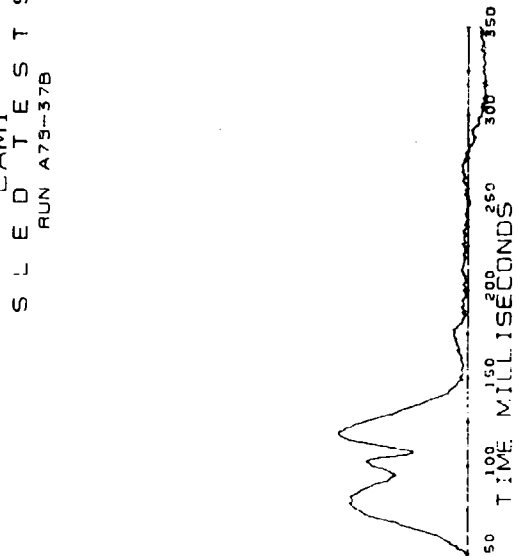
CAMI
S L E D T E S T S
RUN A79-37B

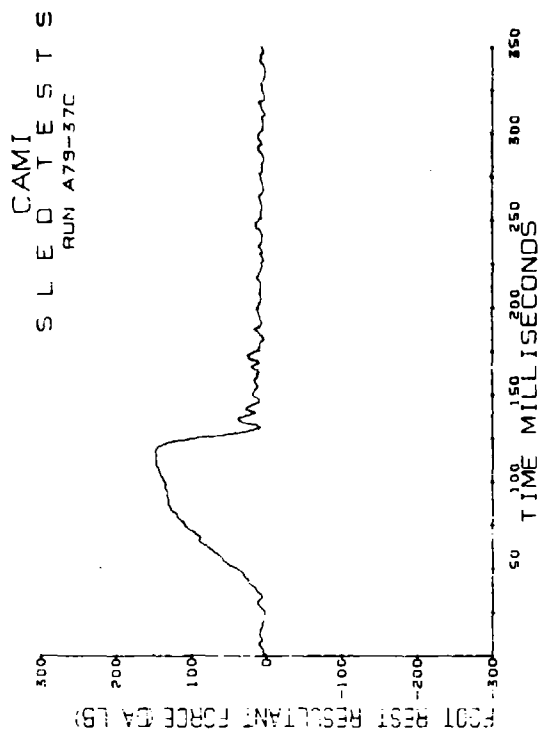
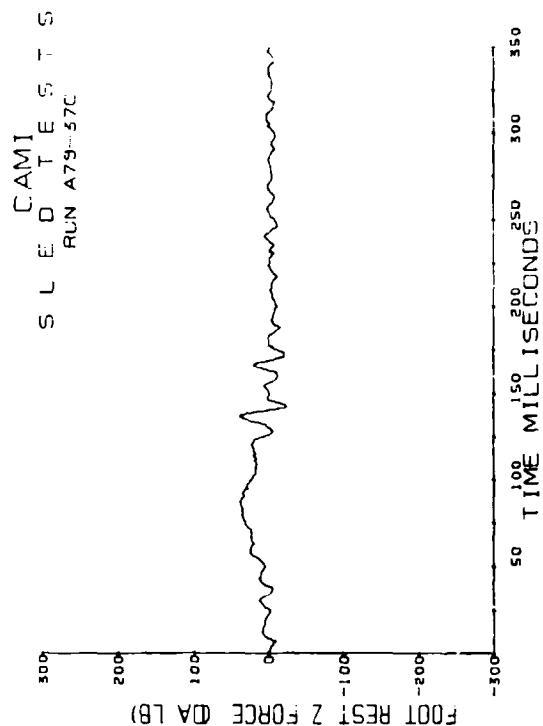
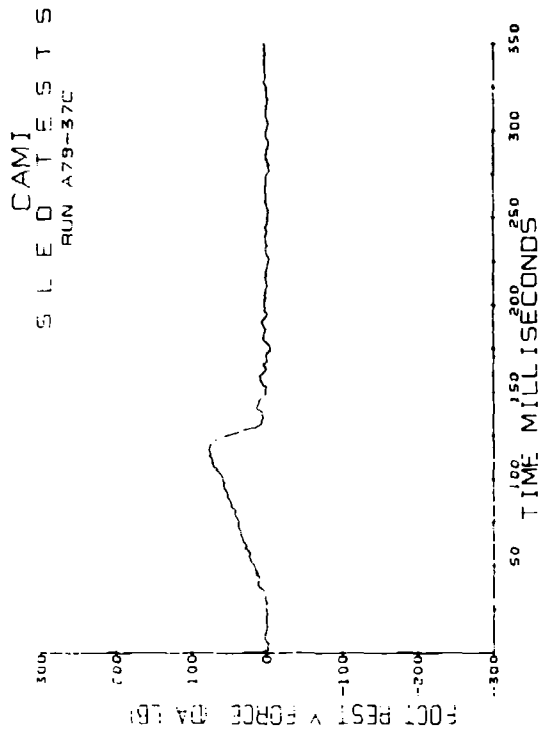
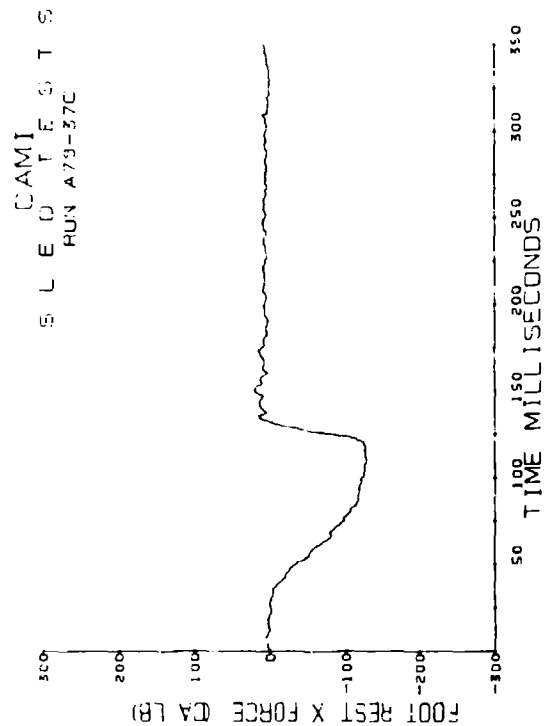
-G LOAD X FORCE (LB)



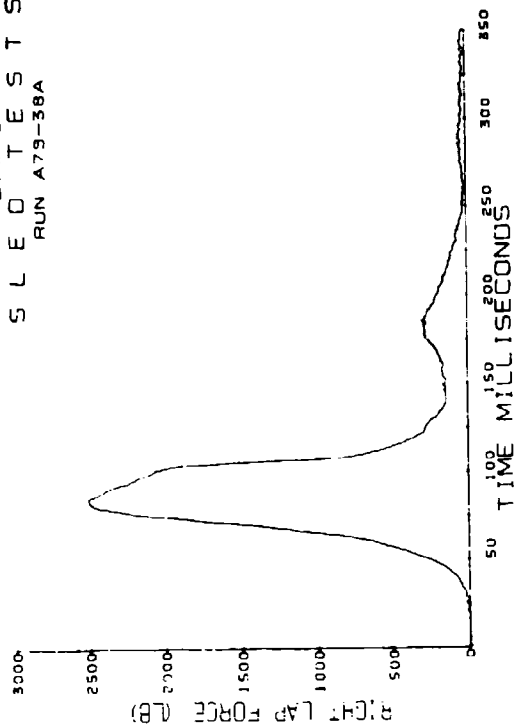
CAMI
S L E D T E S T S
RUN A79-37B

-Z LOAD Z FORCE (LB)

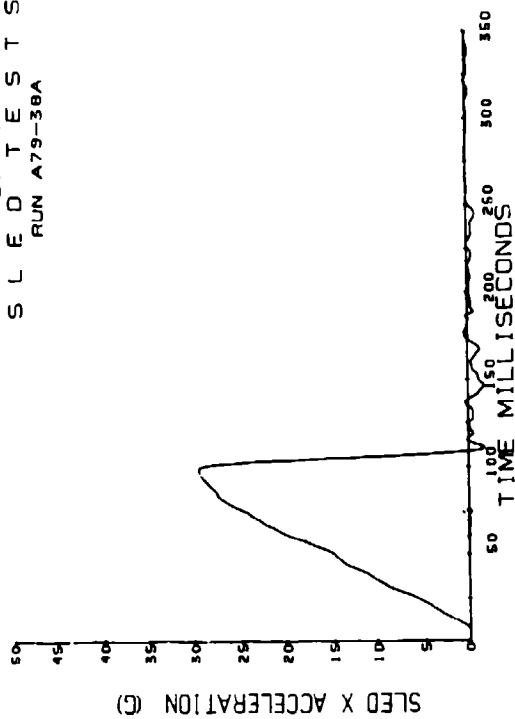




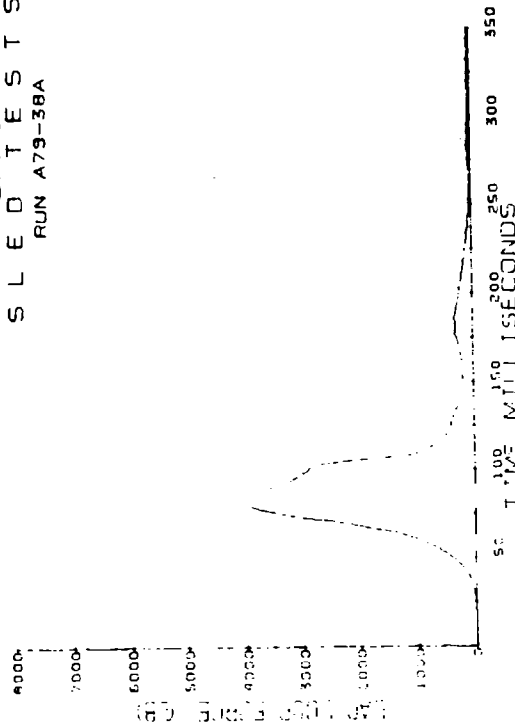
CAMI
S L E D T E S T S
RUN A79-38A



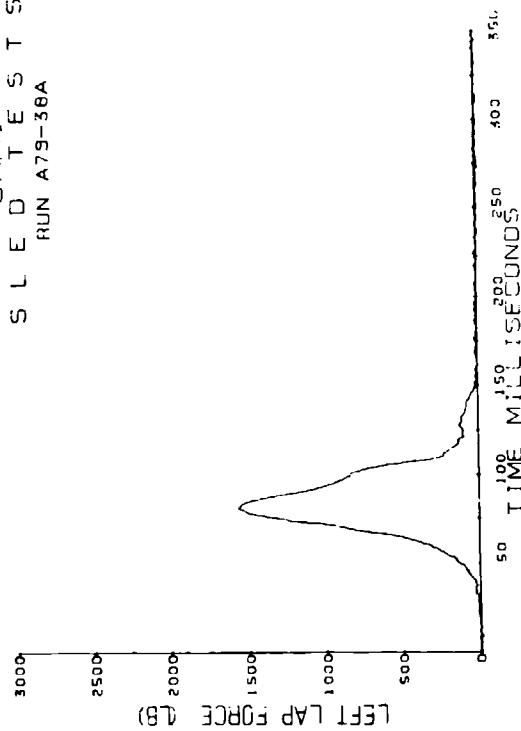
CAMI
S L E D T E S T S
RUN A79-38A



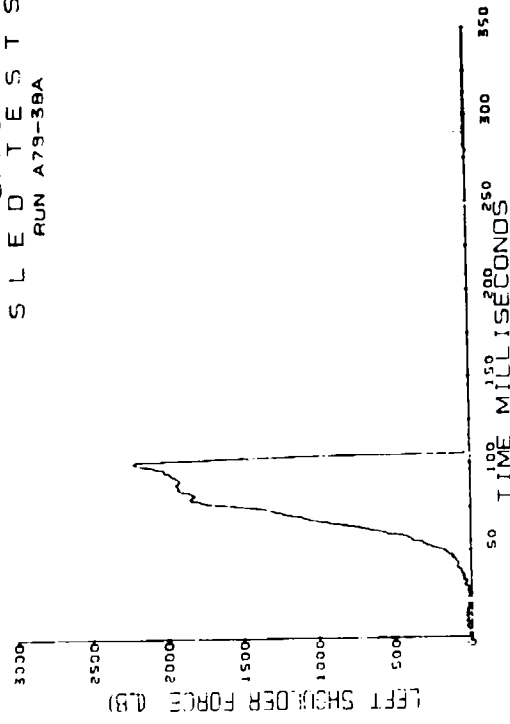
CAMI
S L E D T E S T S
RUN A79-38A



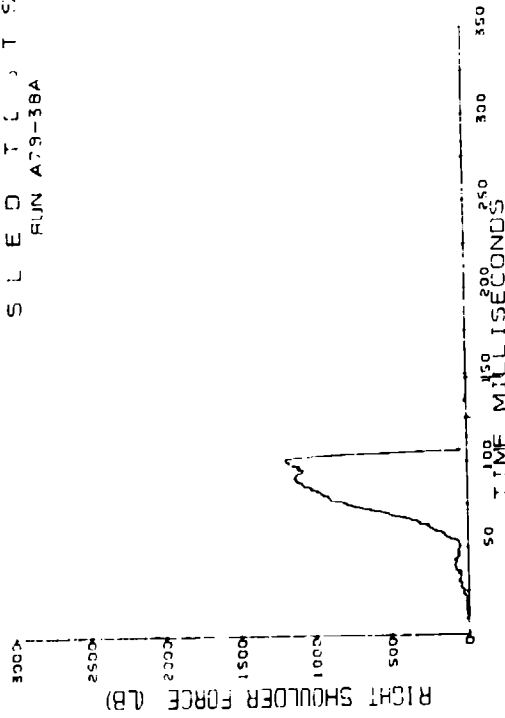
CAMI
S L E D T E S T S
RUN A79-38A



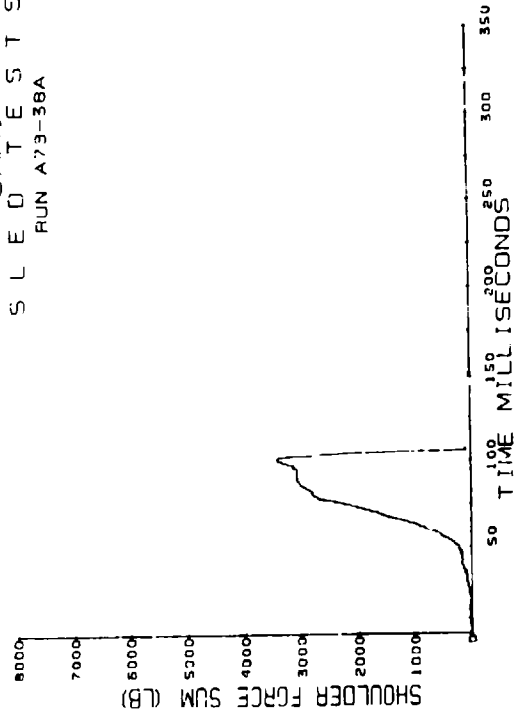
CAMI
S L E D T E S T S
RUN A79-38A

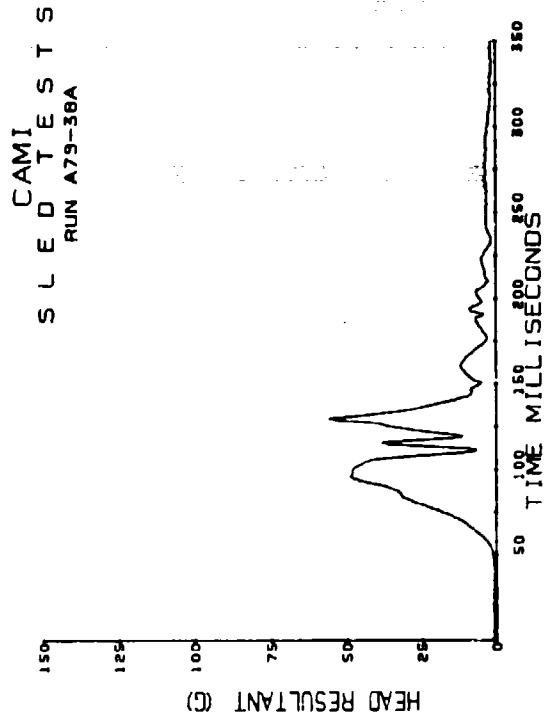
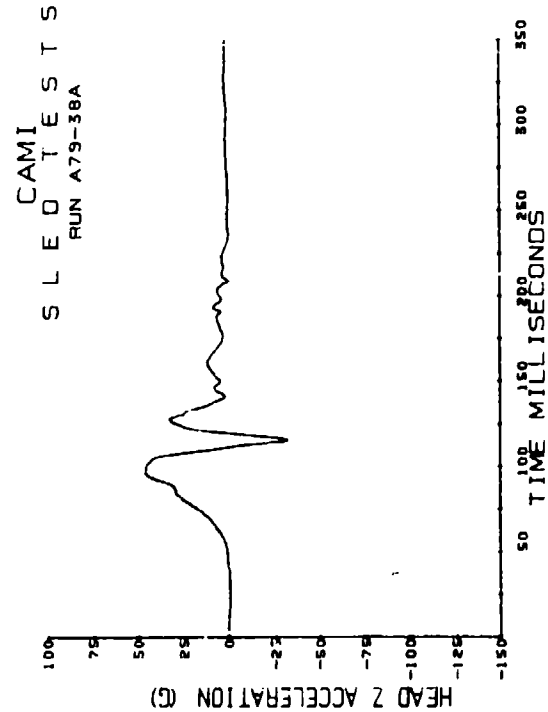
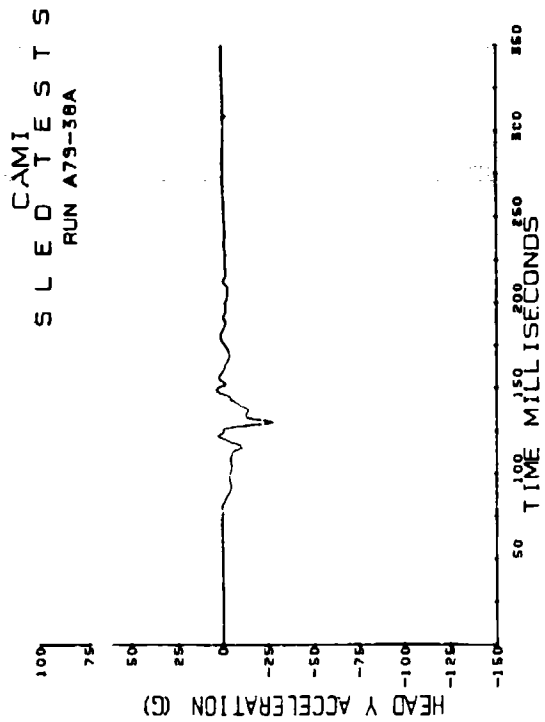
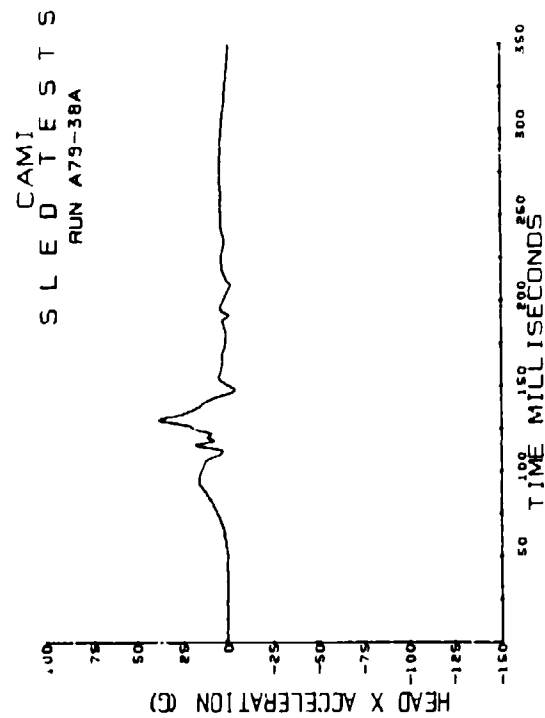


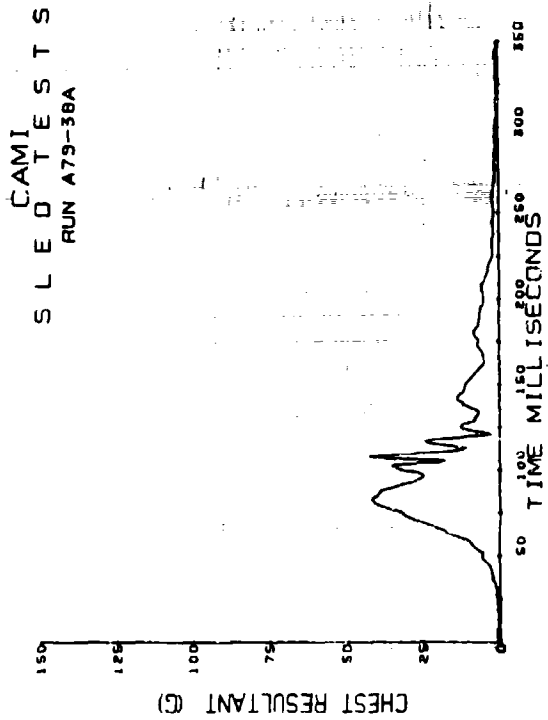
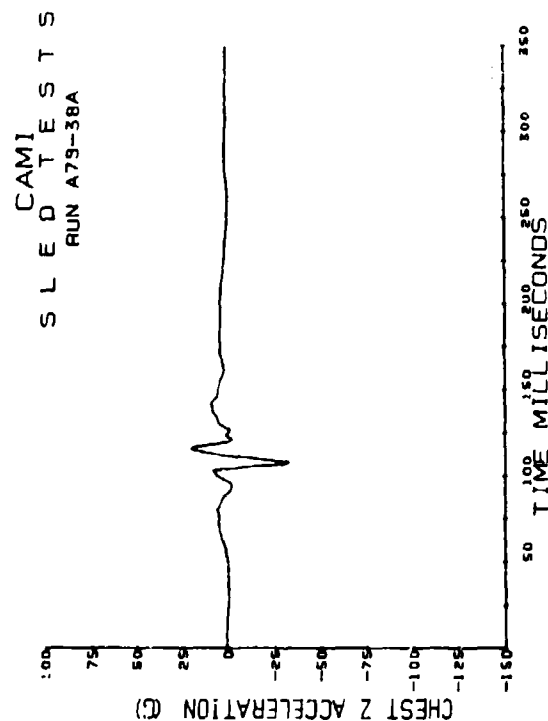
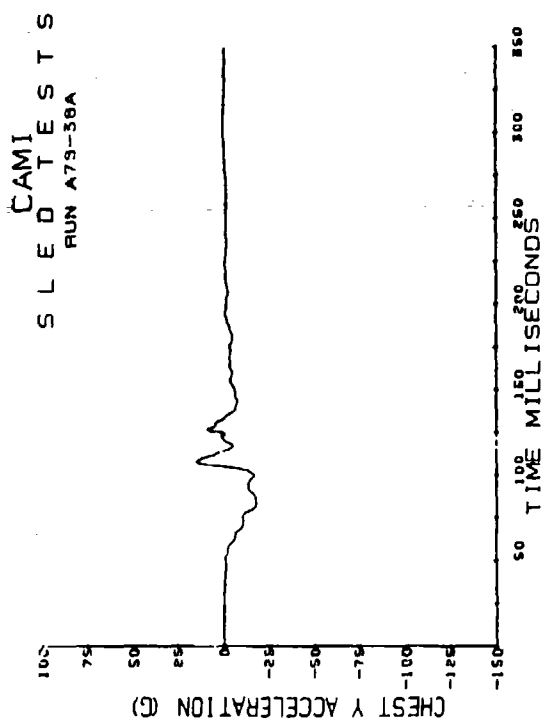
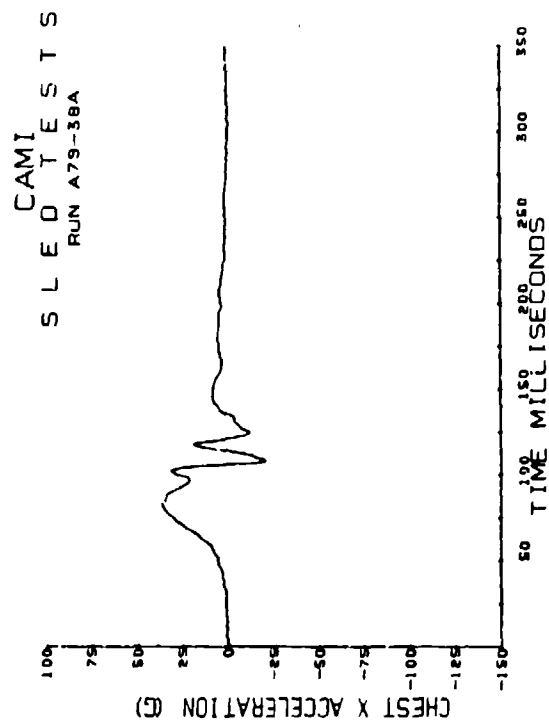
CAMI
S L E D T E S T S
RUN A79-38A



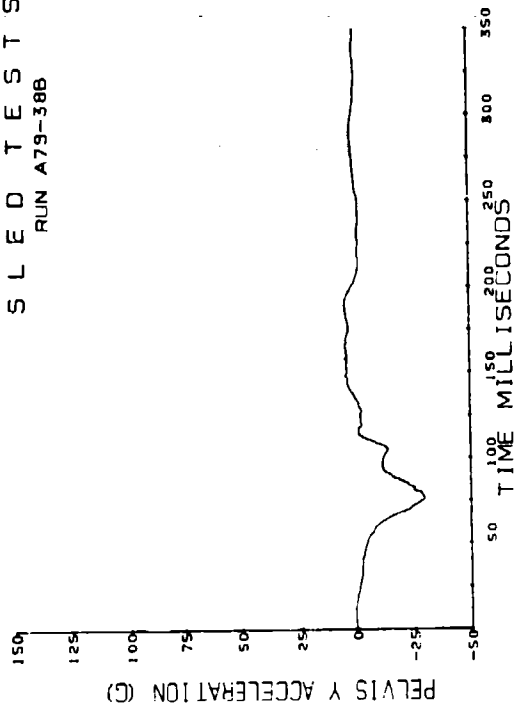
CAMI
S L E D T E S T S
RUN A79-38A



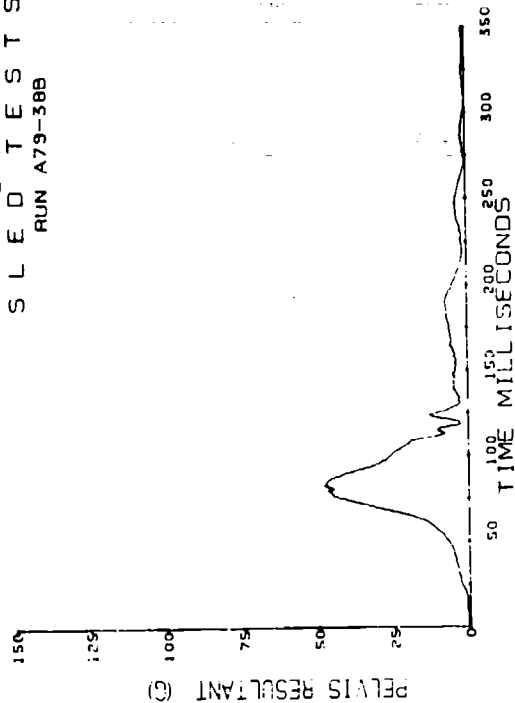




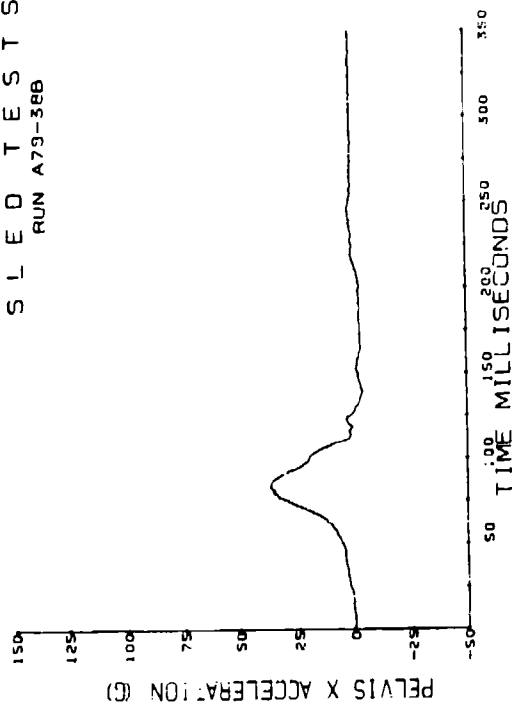
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S L E D T E S T S
RUN A79-38B



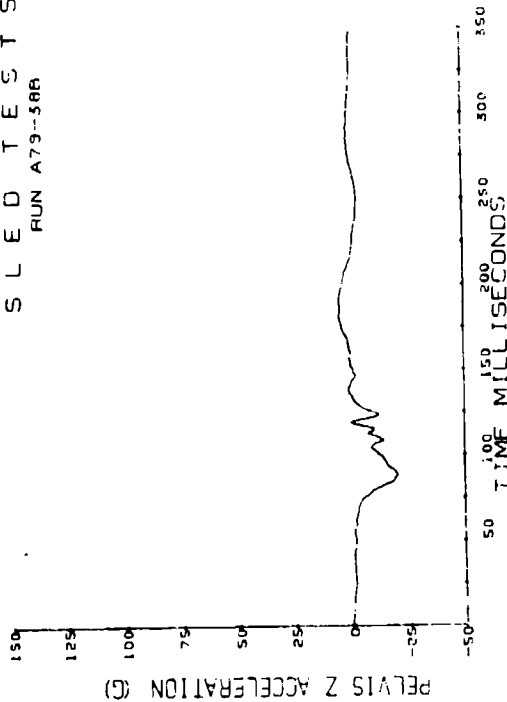
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S L E D T E S T S
RUN A79-38B

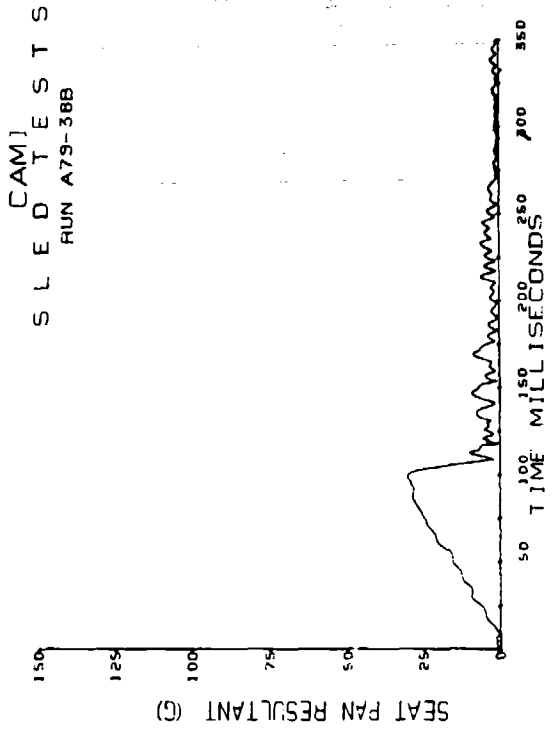
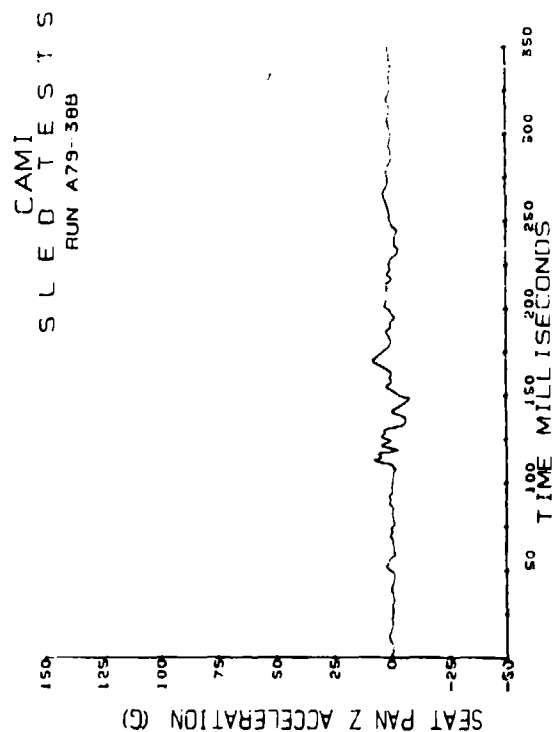
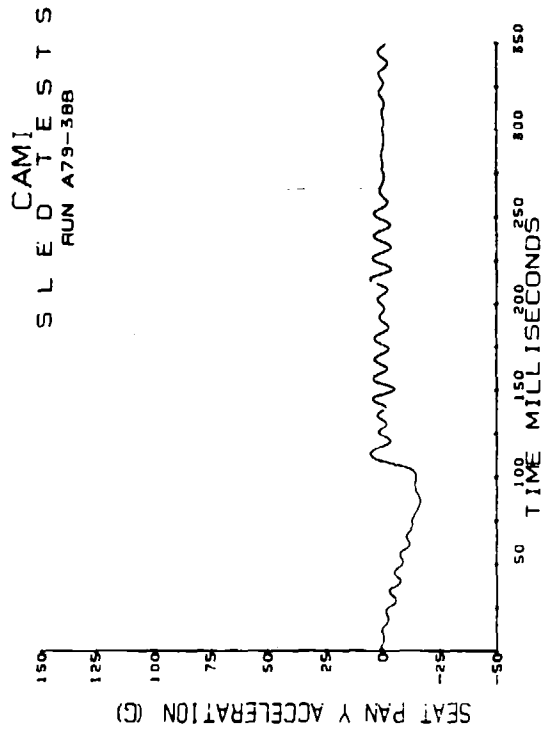
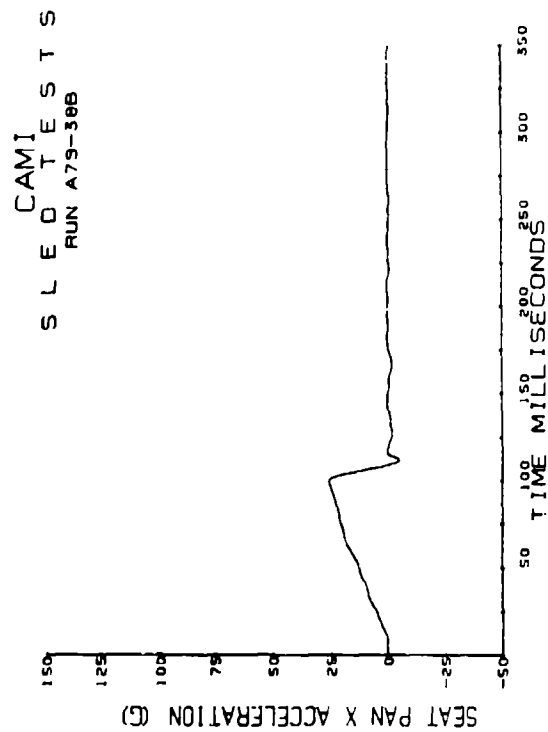


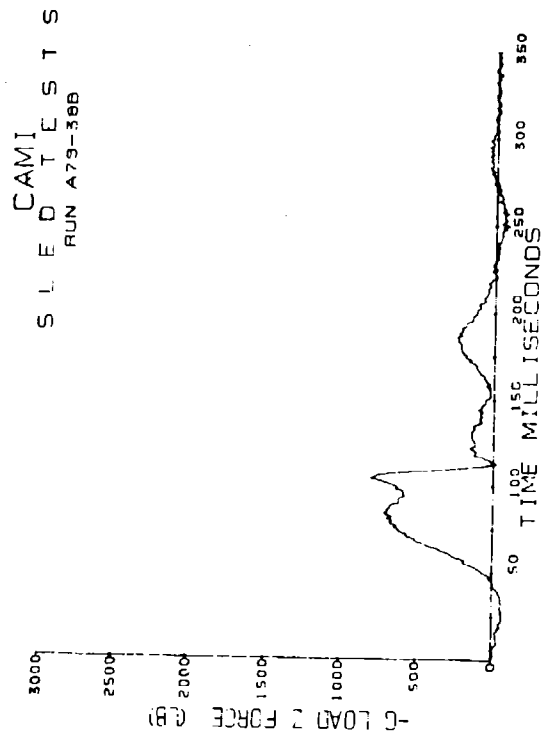
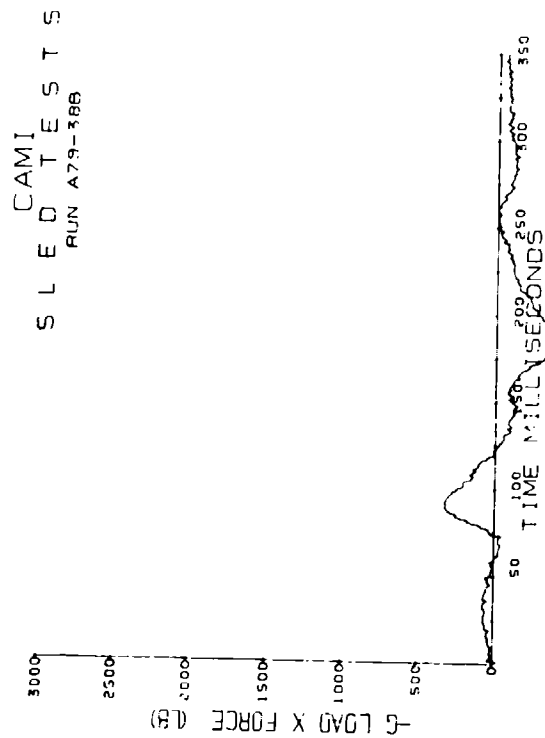
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S L E D T E S T S
RUN A79-38B



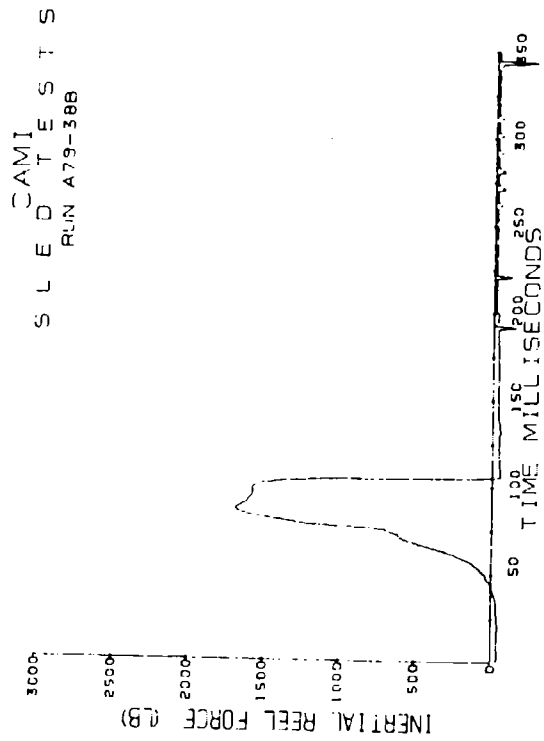
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S L E D T E S T S
RUN A79-38B



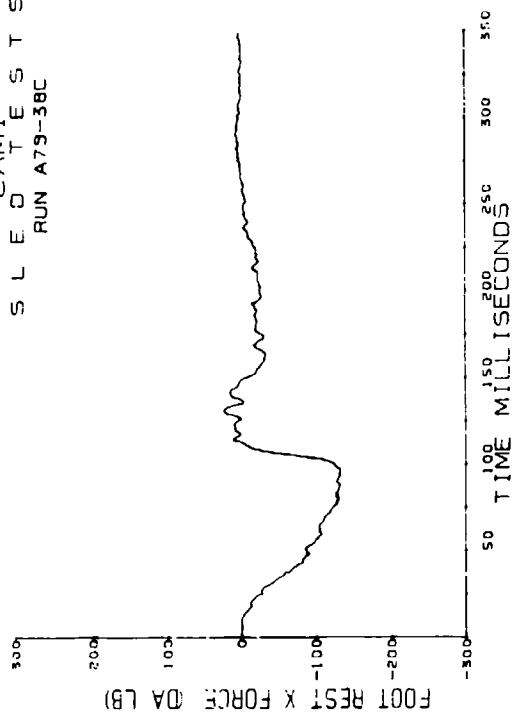




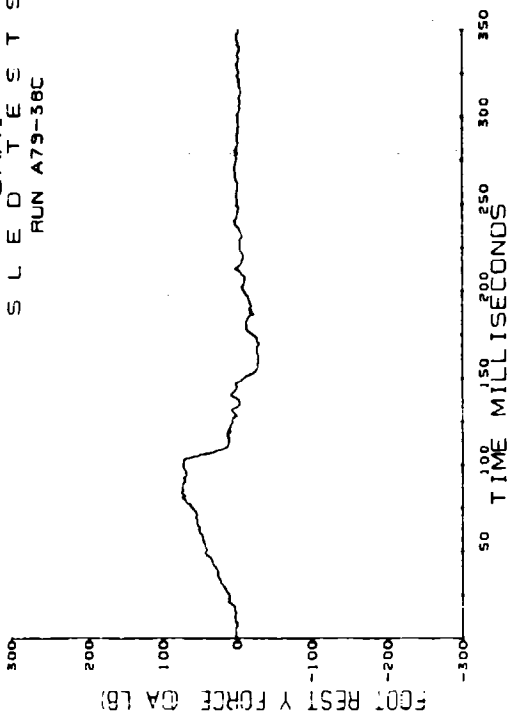
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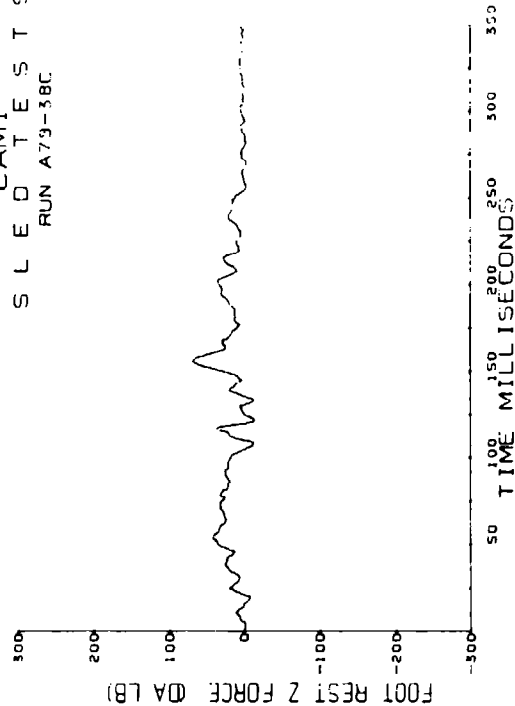
CAMI
S L E D T E S T S
RUN A79-38C



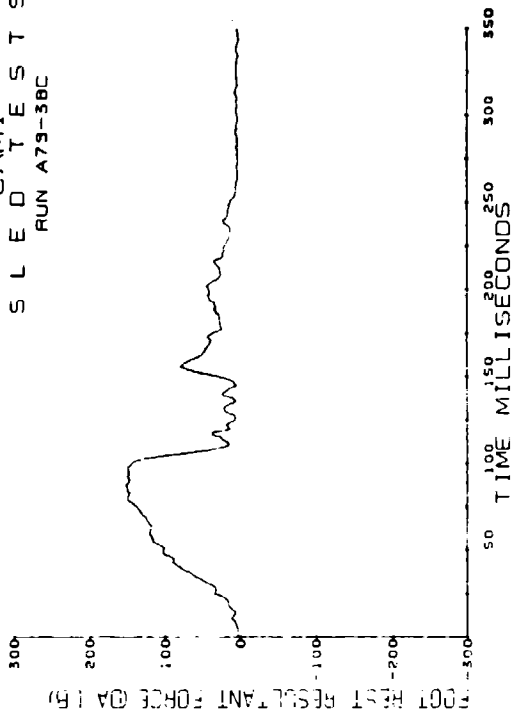
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S L E D T E S T S
RUN A79-38C

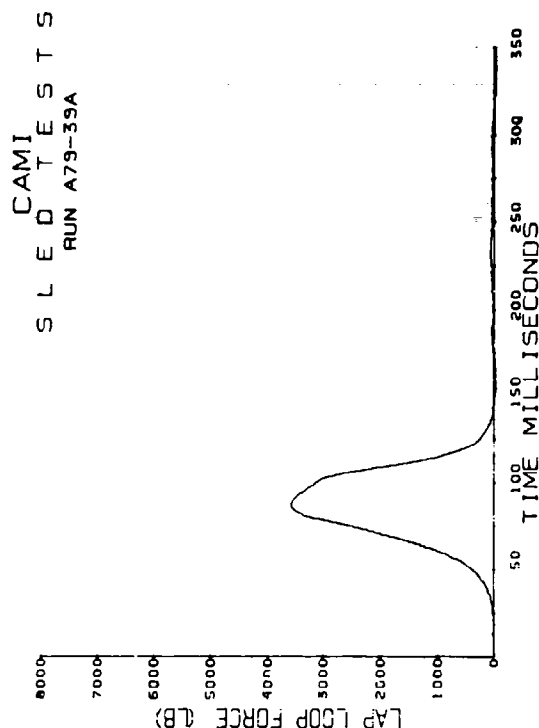
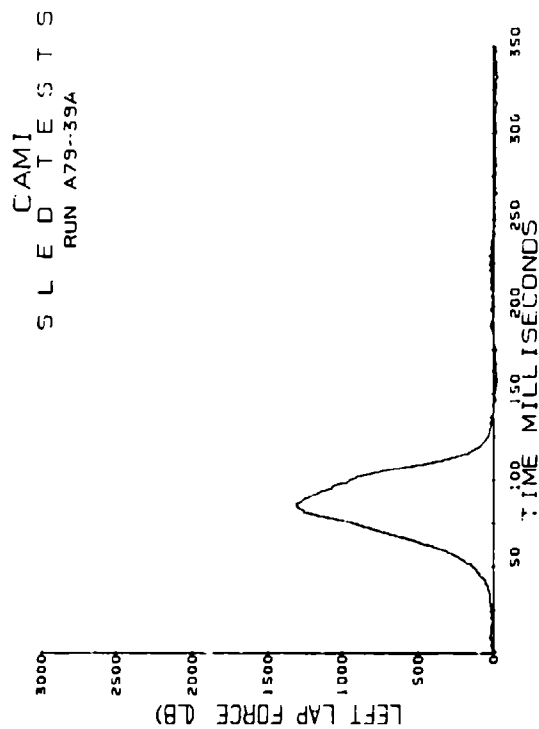
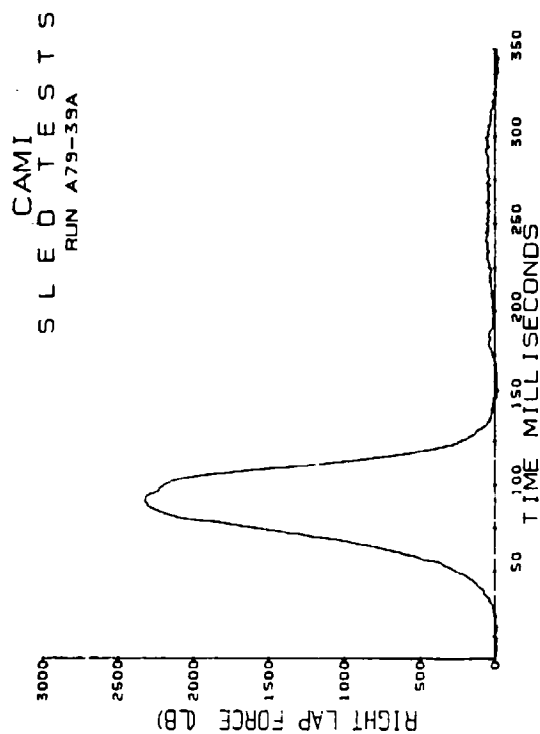
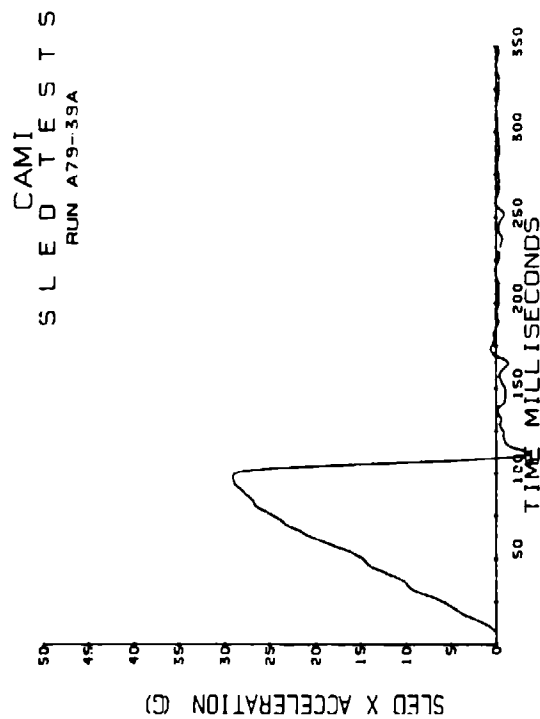


CAMI
S L E D T E S T S
RUN A79-38C

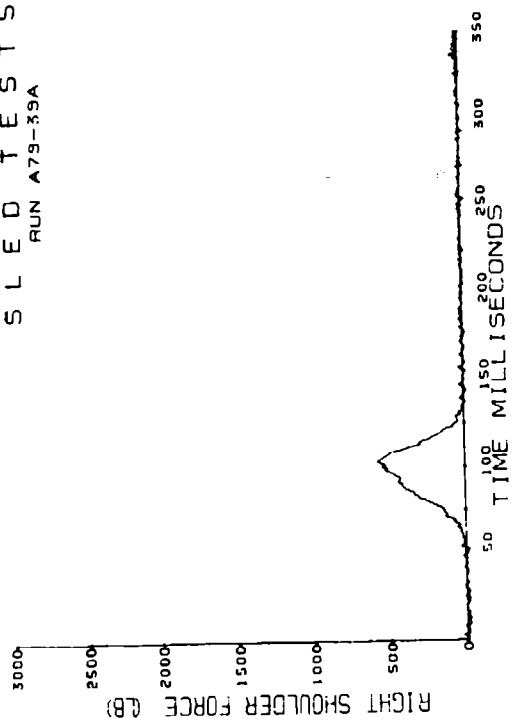


CAMI
S L E D T E S T S
RUN A79-38C

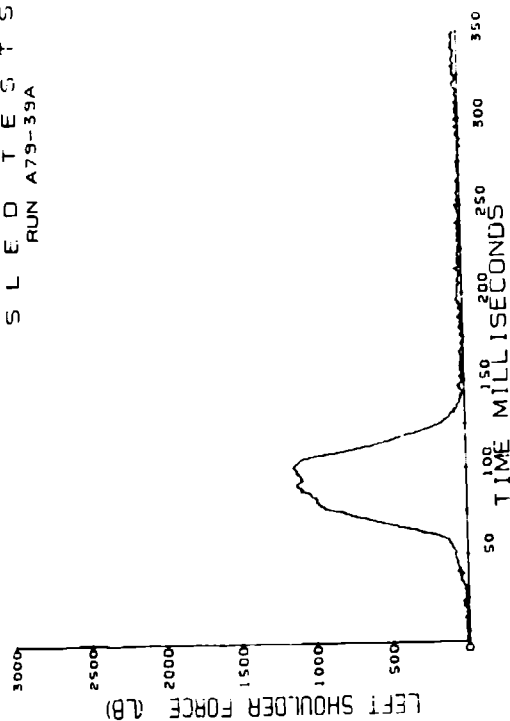




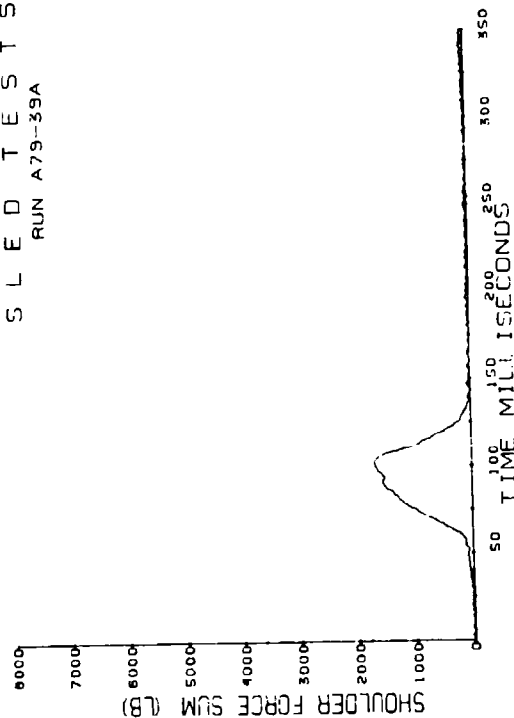
CAMI S L E D T E S T S RUN A79-39A



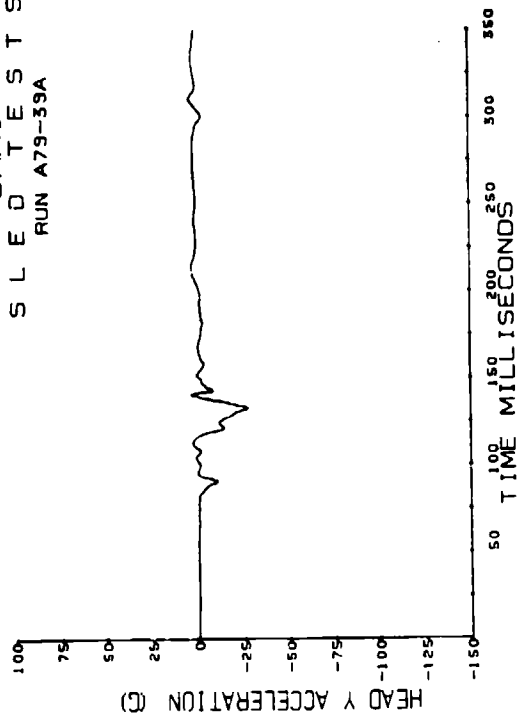
CAMI S L E D T E S T S RUN A79-39A



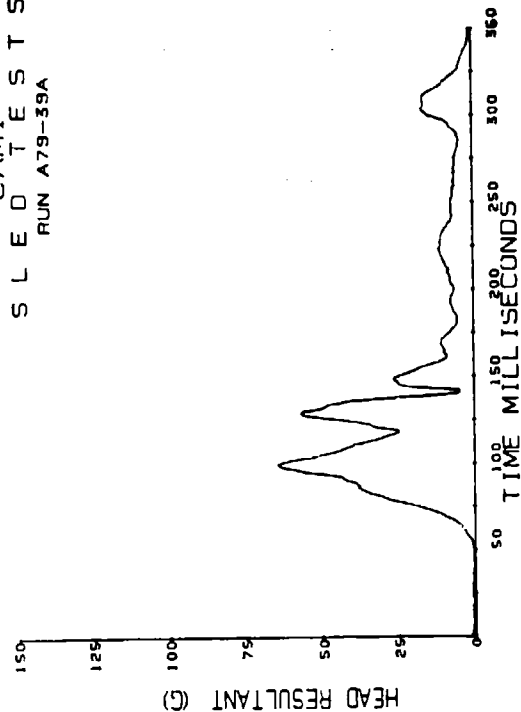
CAMI S L E D T E S T S RUN A79-39A



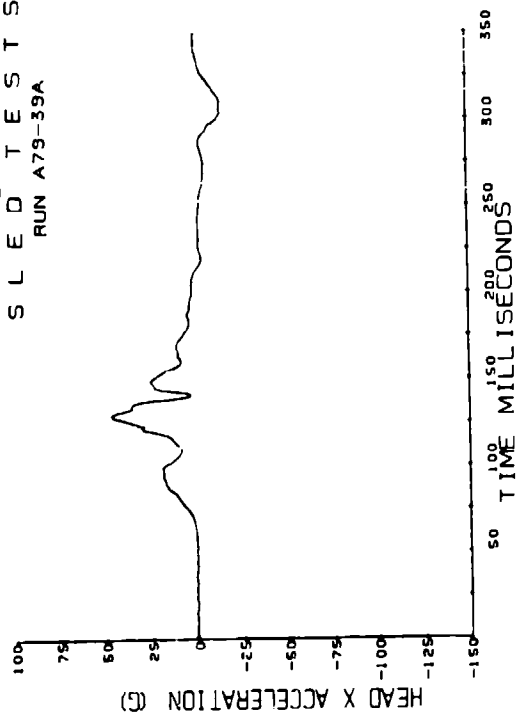
CAMI
S L E D T E S T S
RUN A79-39A



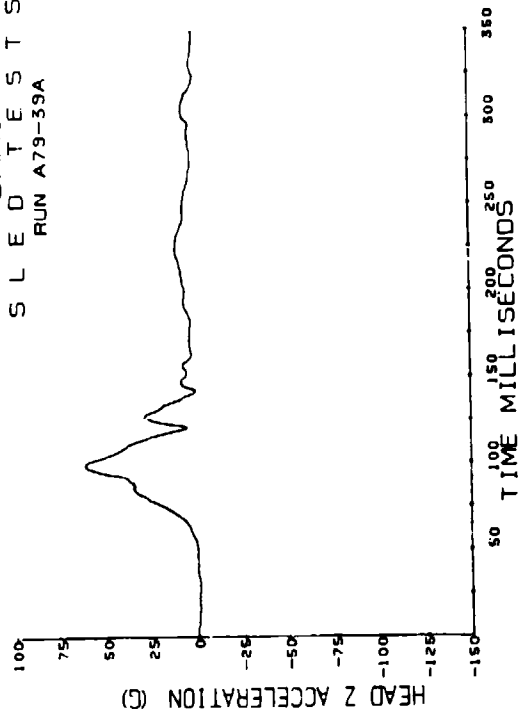
CAMI
S L E D T E S T S
RUN A79-39A



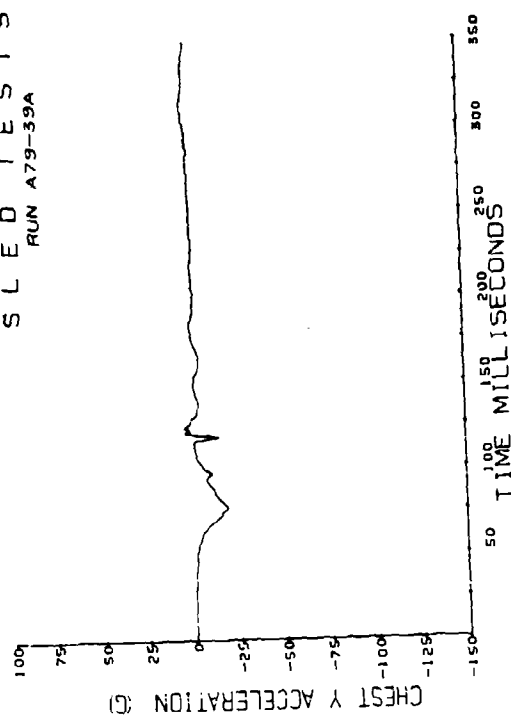
CAMI
S L E D T E S T S
RUN A79-39A



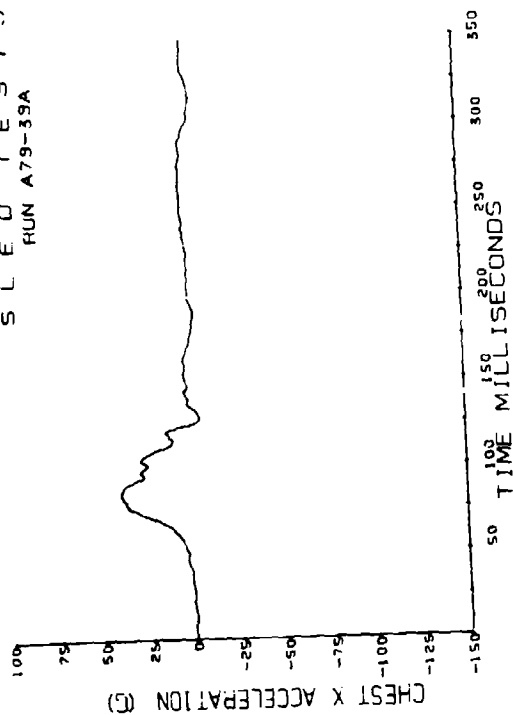
CAMI
S L E D T E S T S
RUN A79-39A



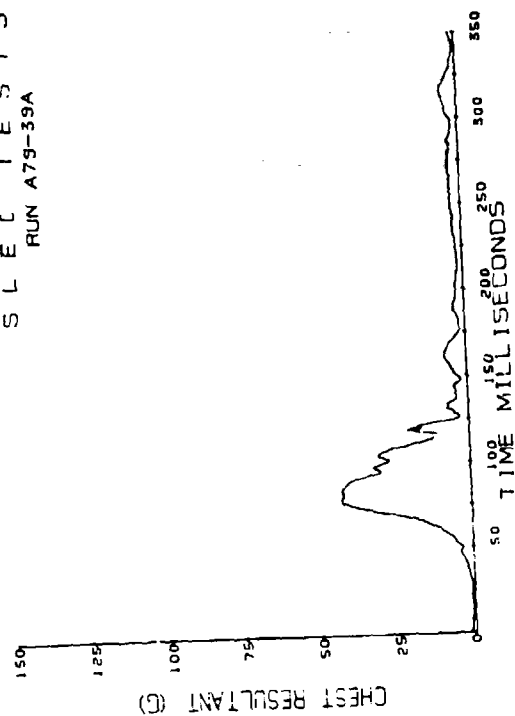
CAMI
S L E D T E S T S
RUN A79-39A



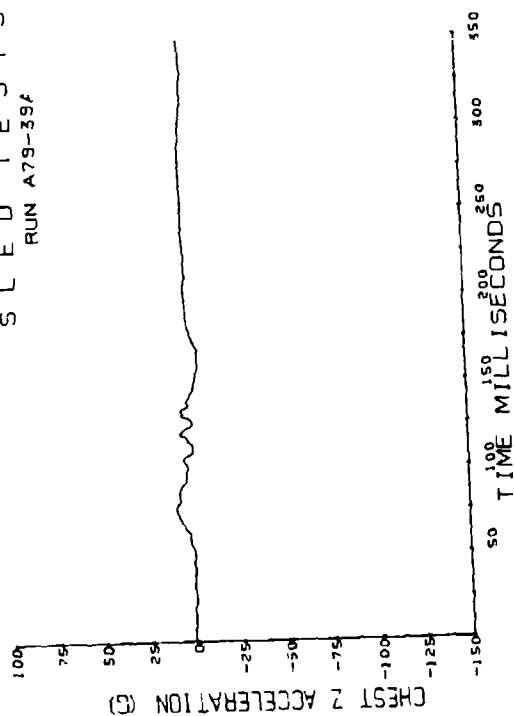
CAMI
S L E D T E S T S
RUN A79-39A

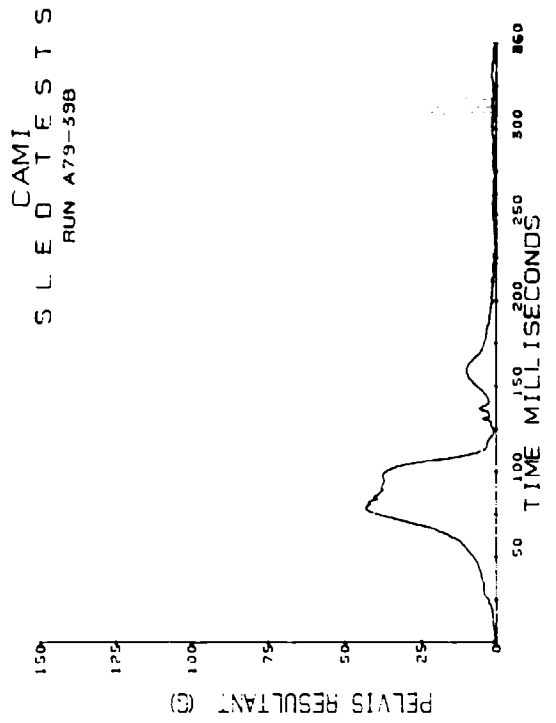
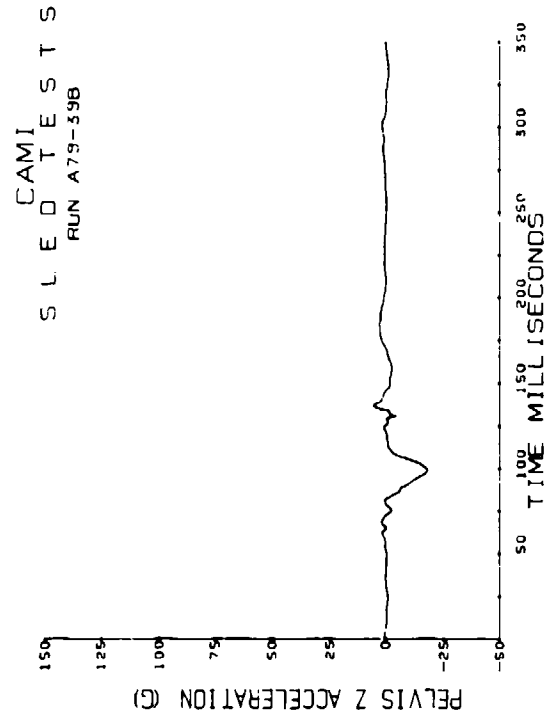
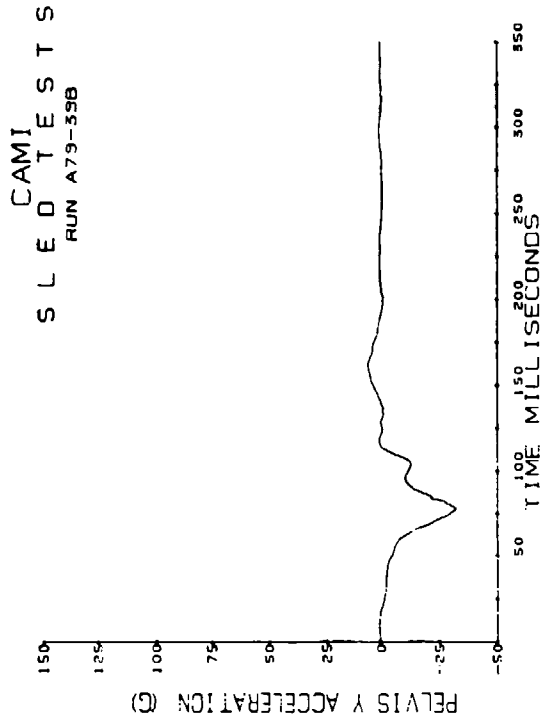
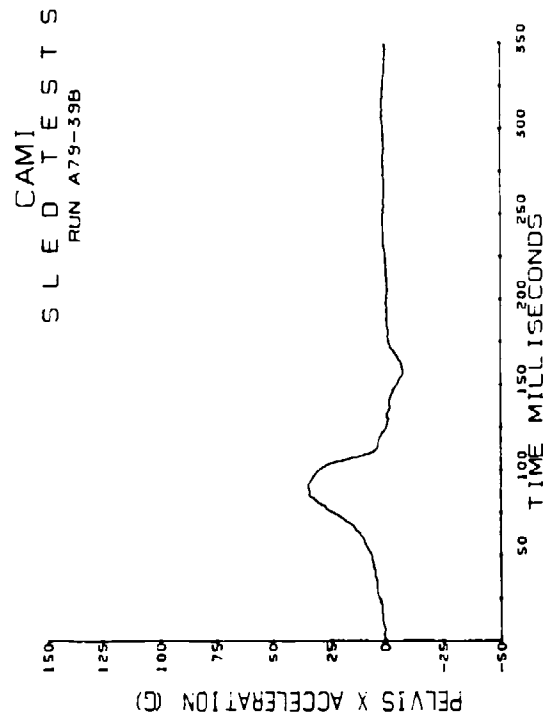


CAMI
S L E D T E S T S
RUN A79-39A

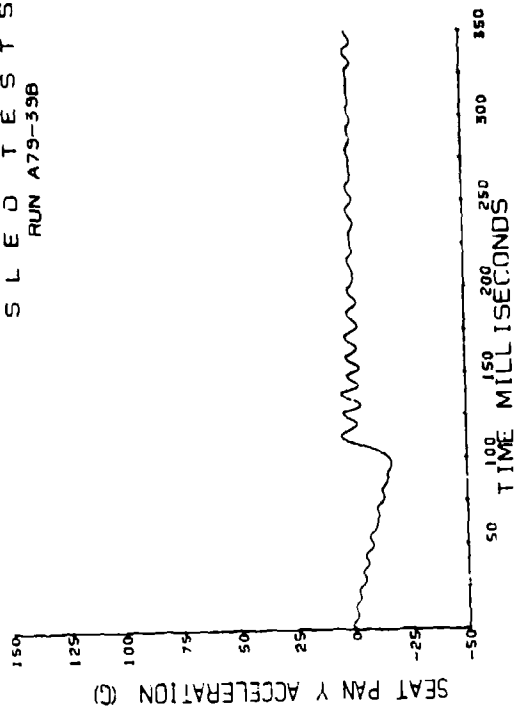


CAMI
S L E D T E S T S
RUN A79-39F

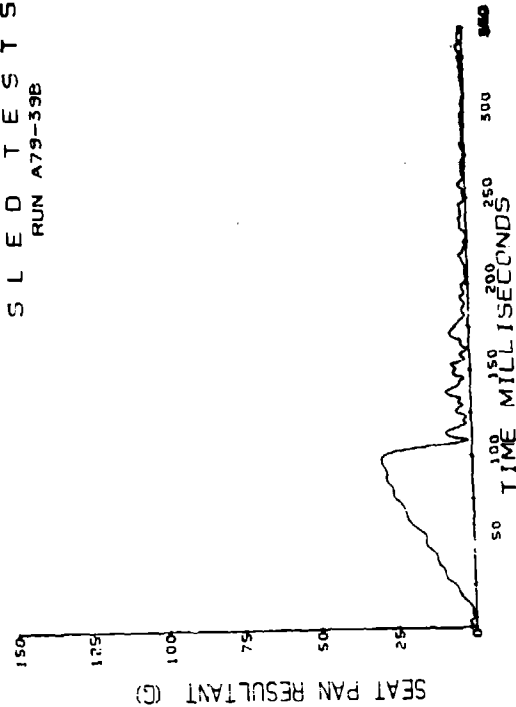




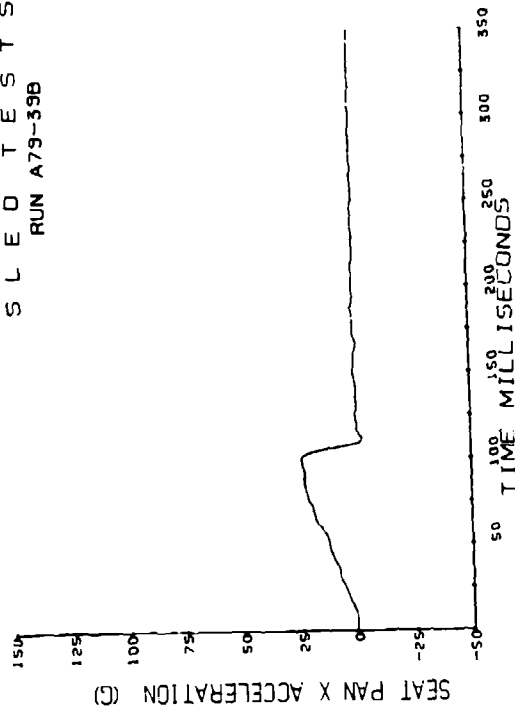
CAMI
S L E D T E S T S
RUN A79-39B



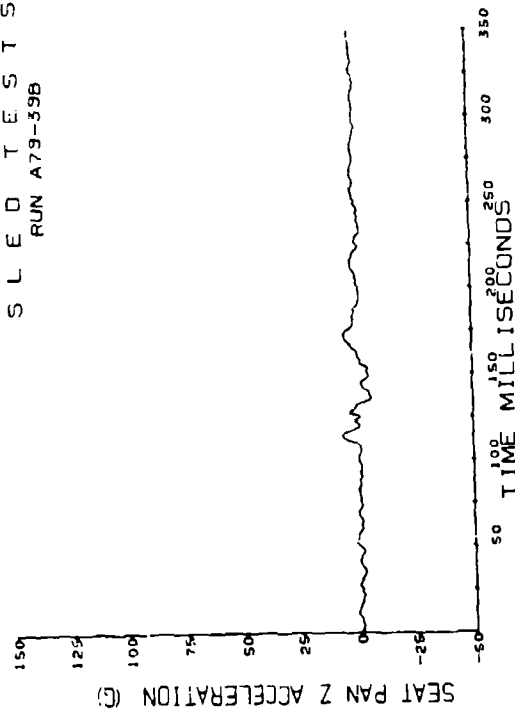
CAMI
S L E D T E S T S
RUN A79-39B



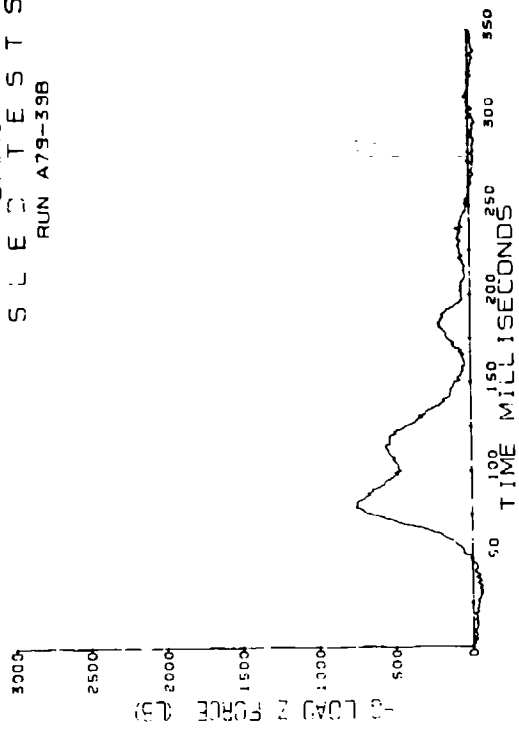
CAMI
S L E D T E S T S
RUN A79-39B



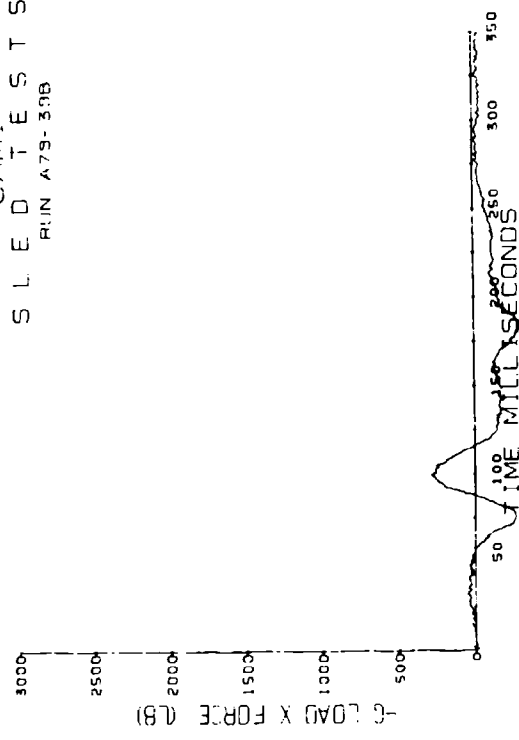
CAMI
S L E D T E S T S
RUN A79-39B



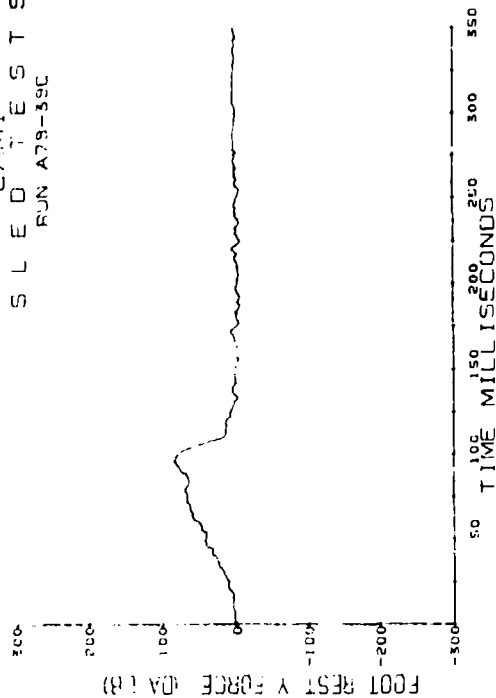
CAM1
S L E D T E S T S
RUN A79-39B



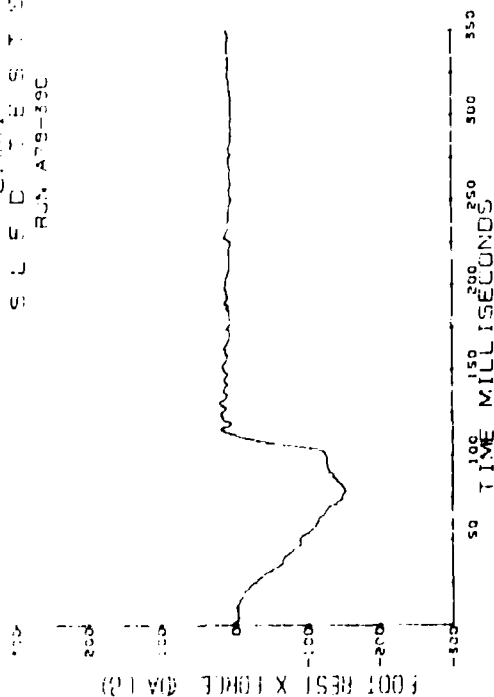
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S L E D T E S T S
RUN A79-39B



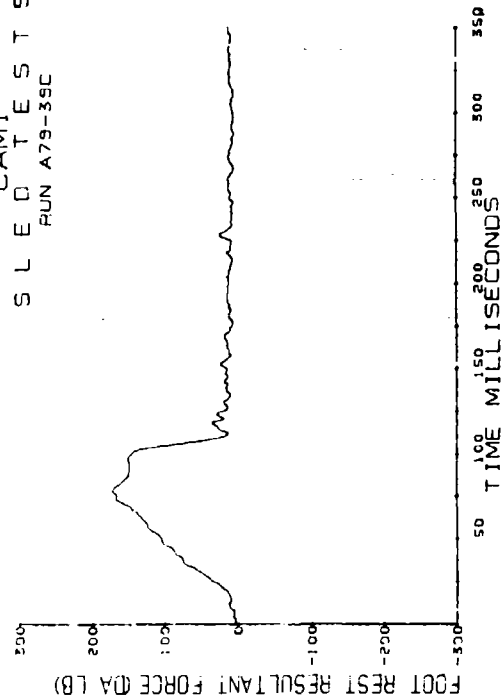
CAMI
S L E D T E S T S
RUN A79-39C



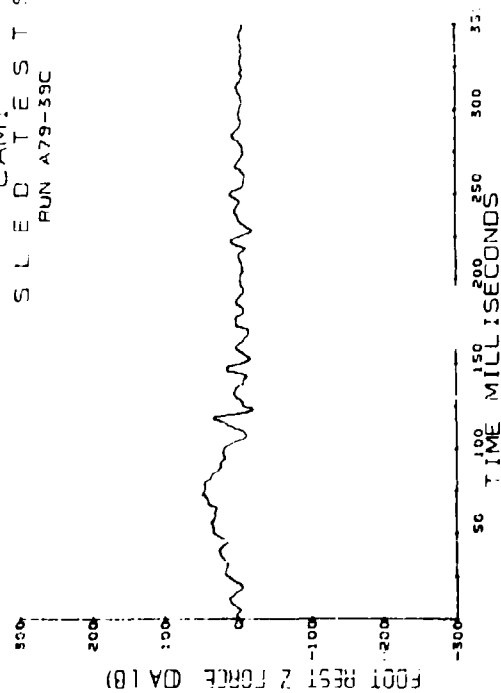
CAMI
S L E D T E S T S
RUN A79-39C



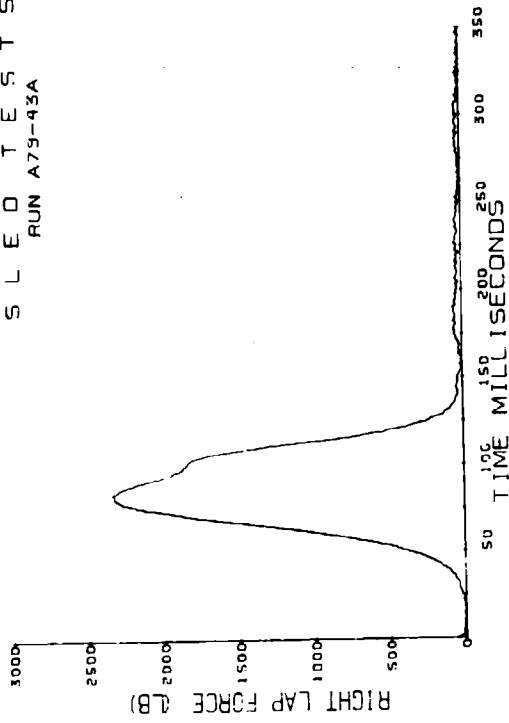
CAMI
S L E D T E S T S
RUN A79-39C



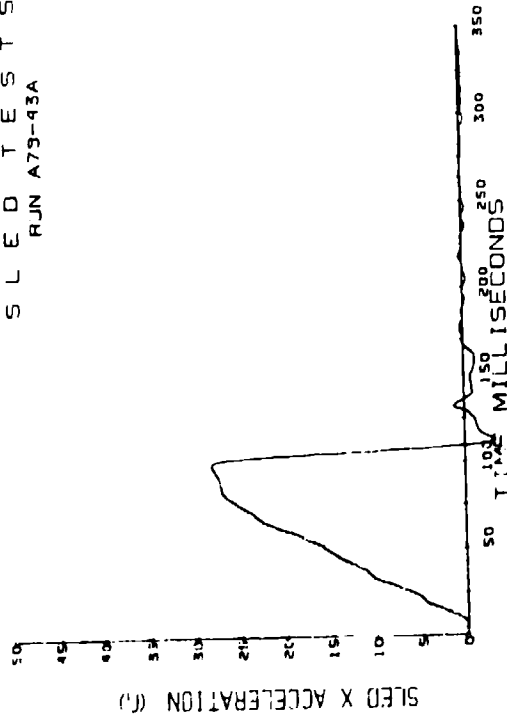
CAMI
S L E D T E S T S
RUN A79-39C



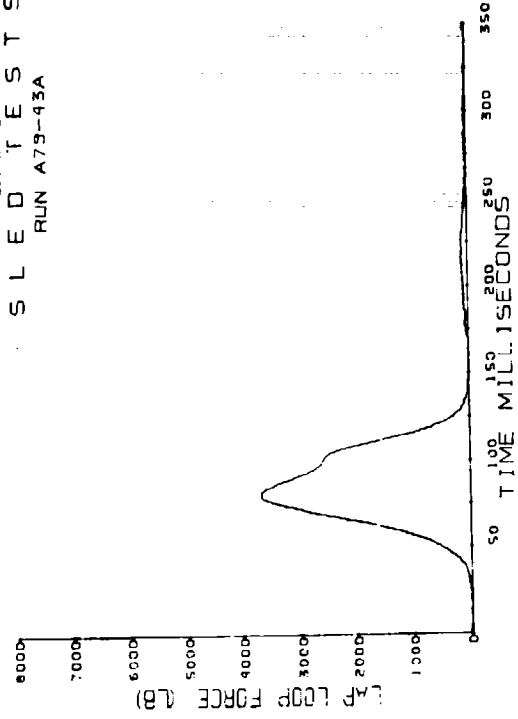
CAMI
S L E D T E S T S
RUN A79-43A



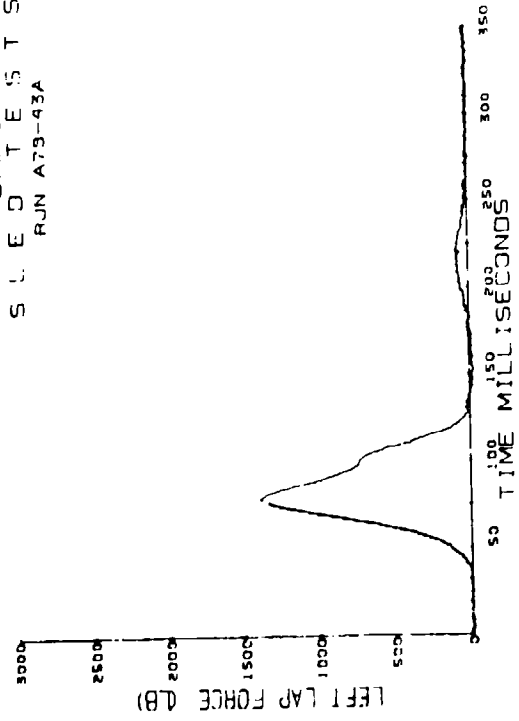
CAMI
S L E D T E S T S
RUN A79-43A

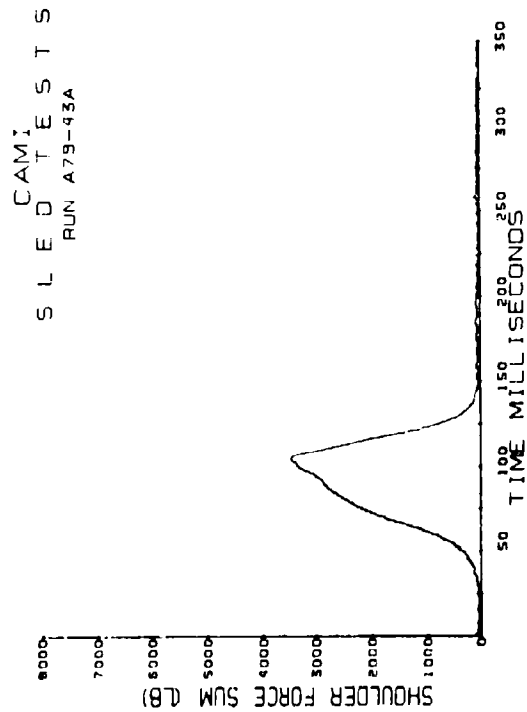
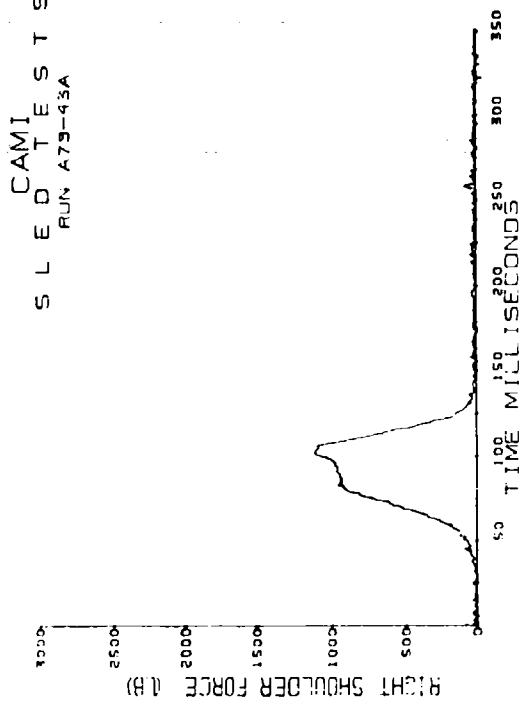
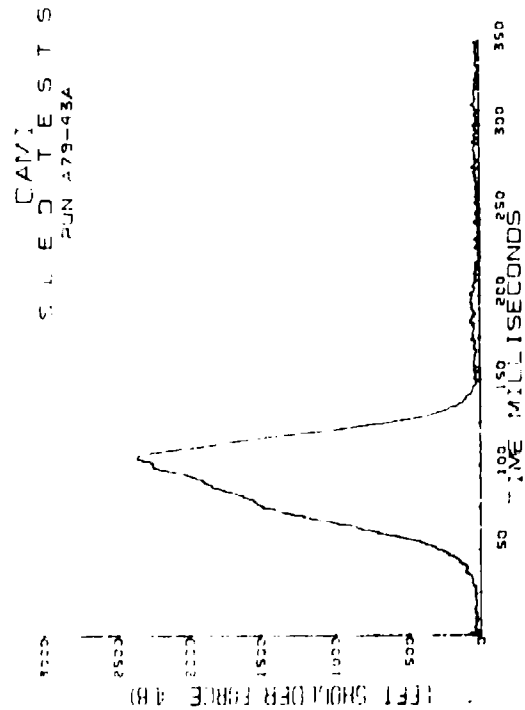


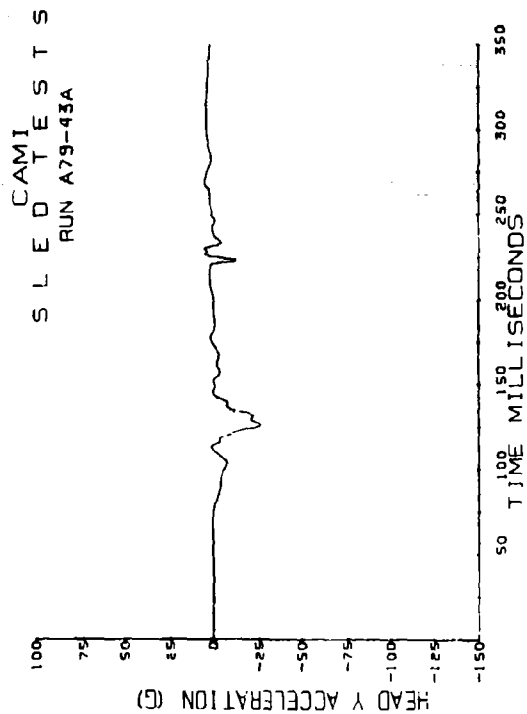
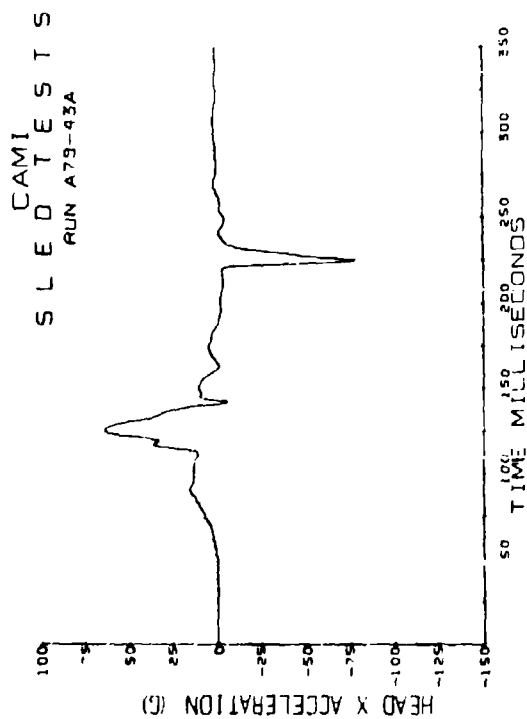
CAMI
S L E D T E S T S
RUN A79-43A



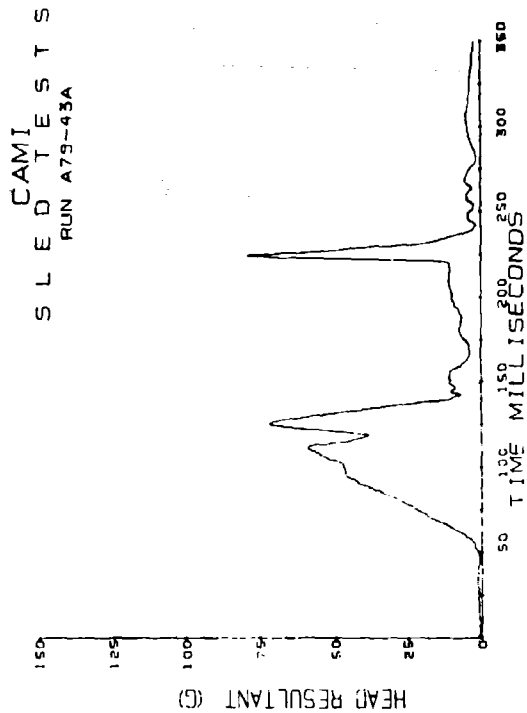
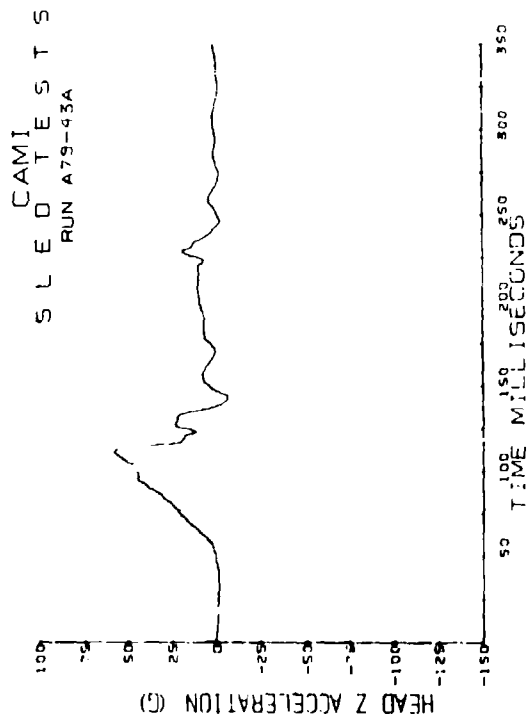
CAMI
S L E D T E S T S
RUN A79-43A



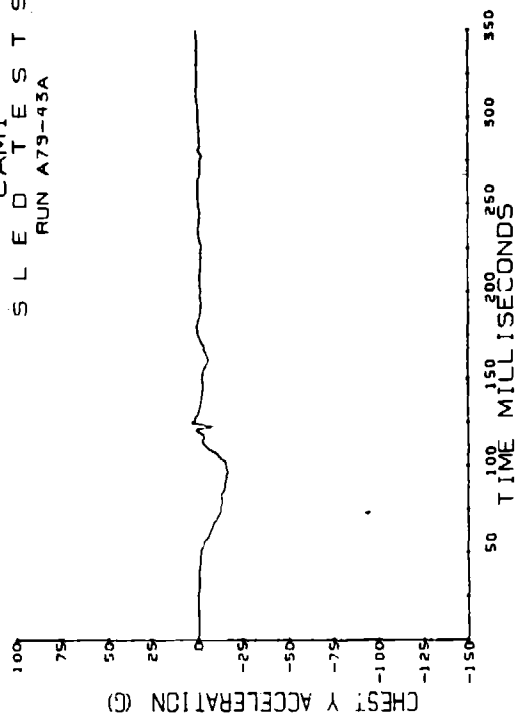




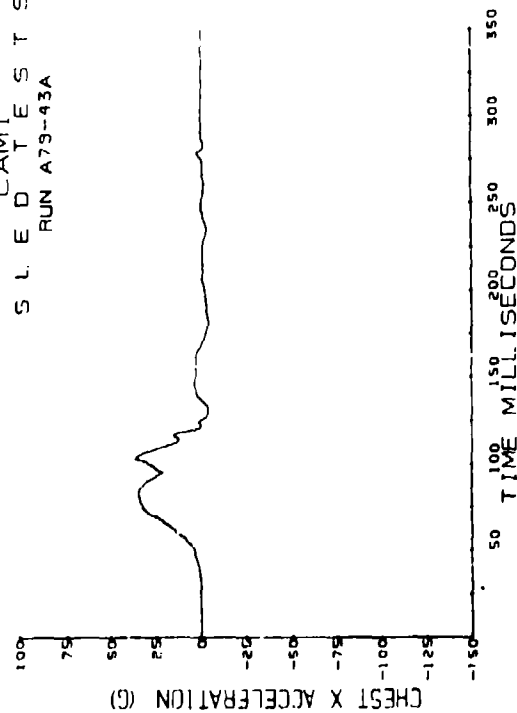
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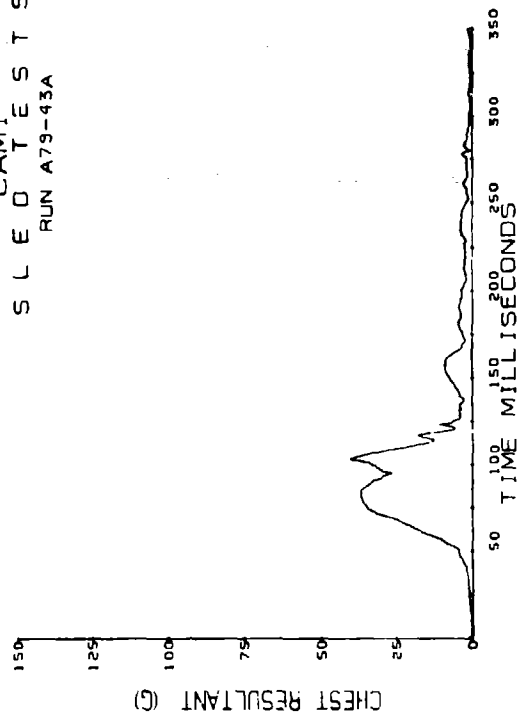
CAMI
S L E D T E S T S
RUN A79-43A



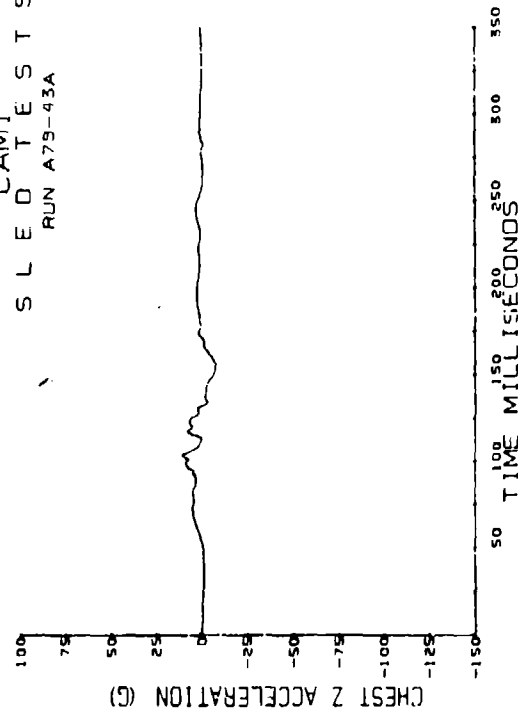
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S L E D T E S T S
RUN A79-43A



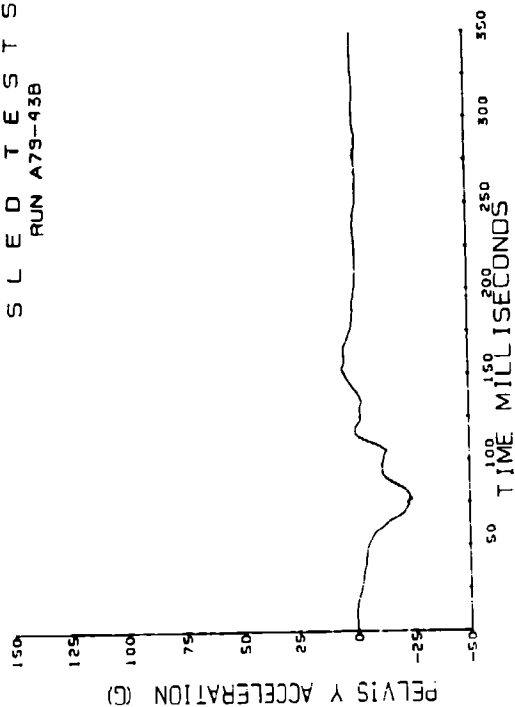
CAMI
S L E D T E S T S
RUN A79-43A



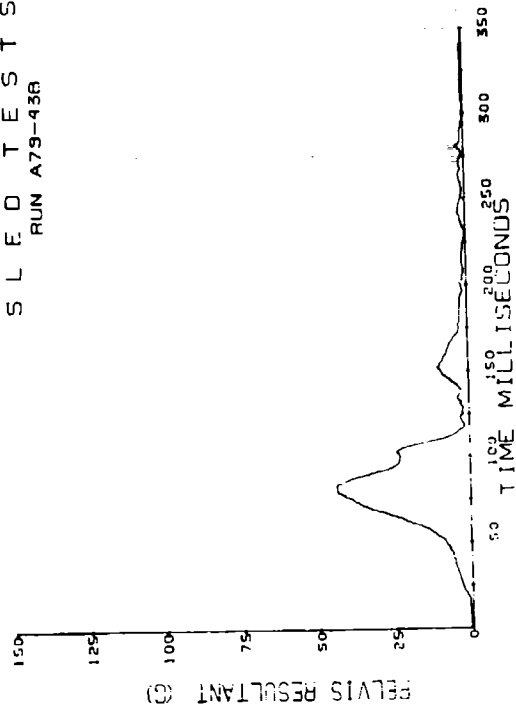
CAMI
S L E D T E S T S
RUN A79-43A



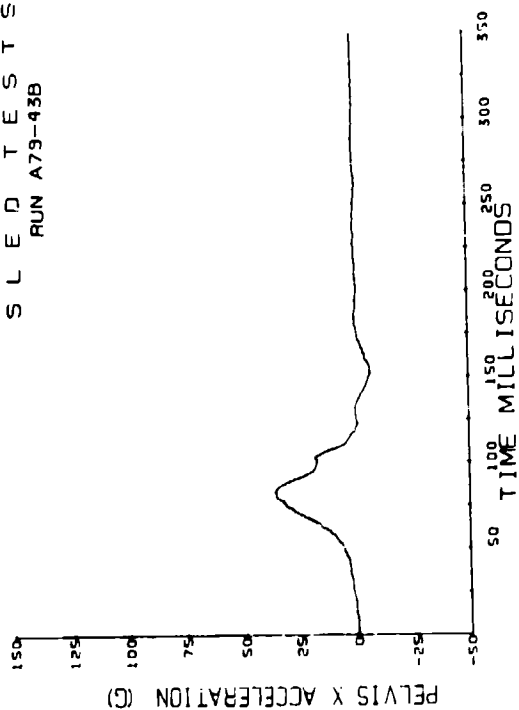
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S L E D T E S T S
RUN A79-43B



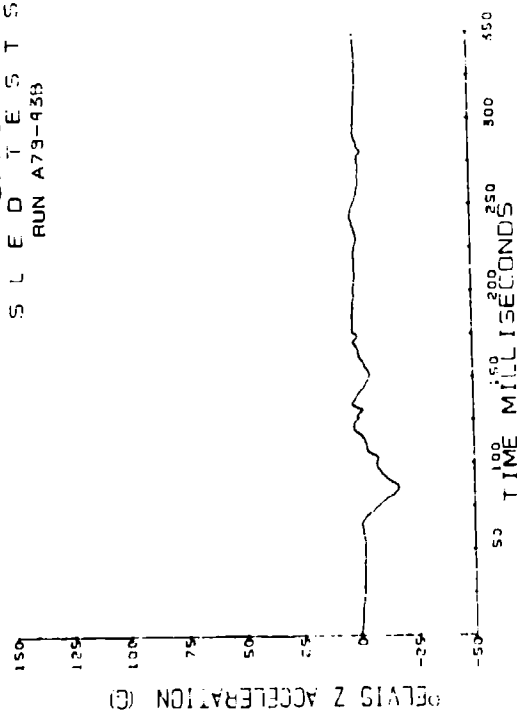
CAMI
S L E D T E S T S
RUN A79-43B

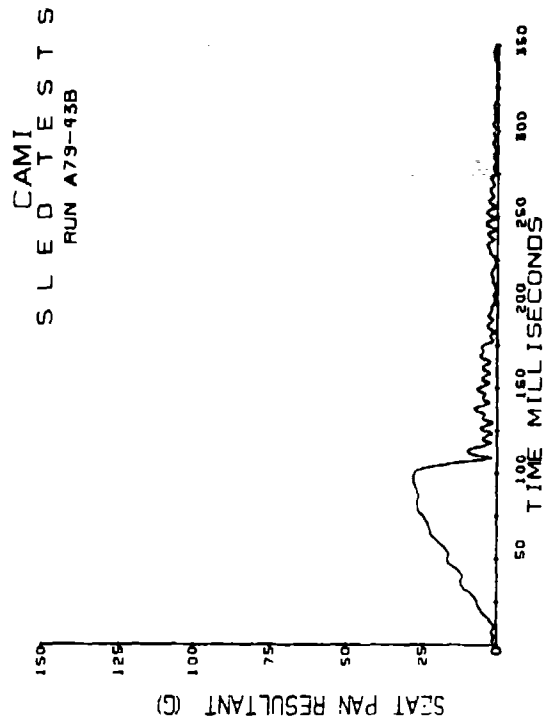
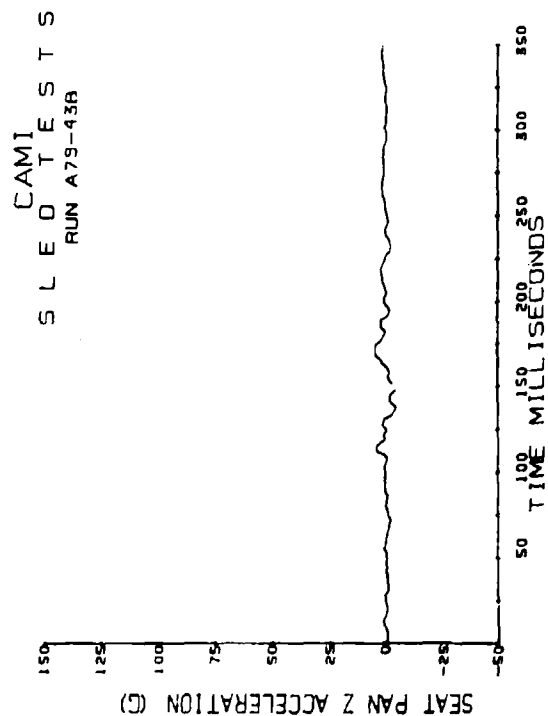
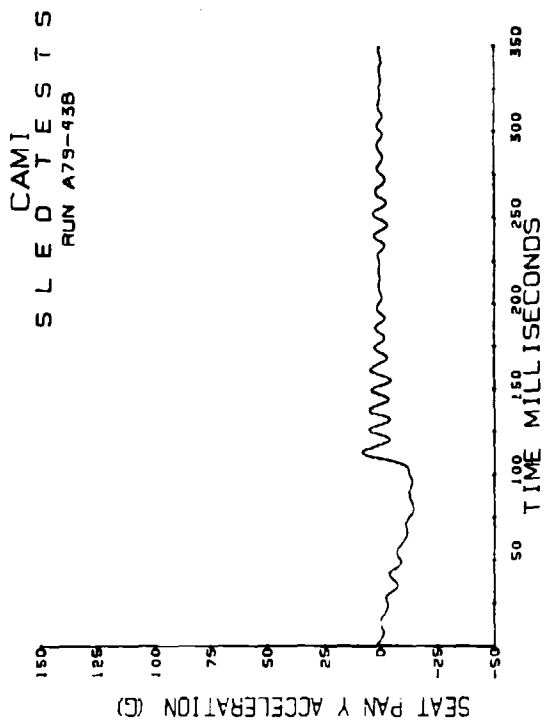
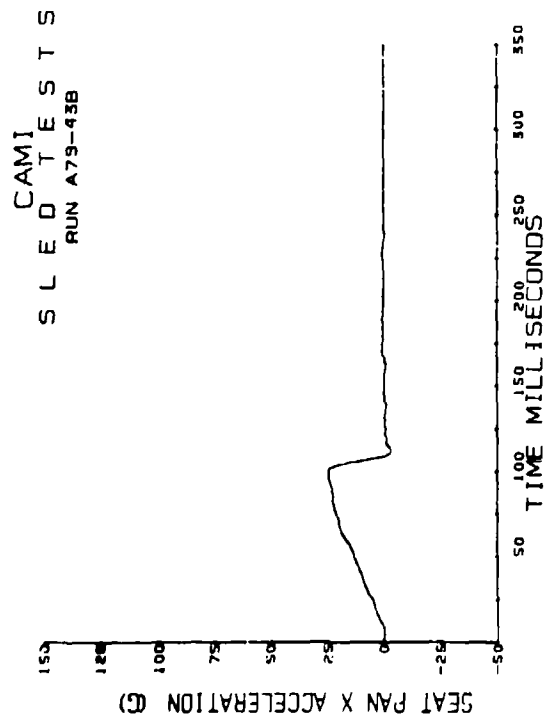


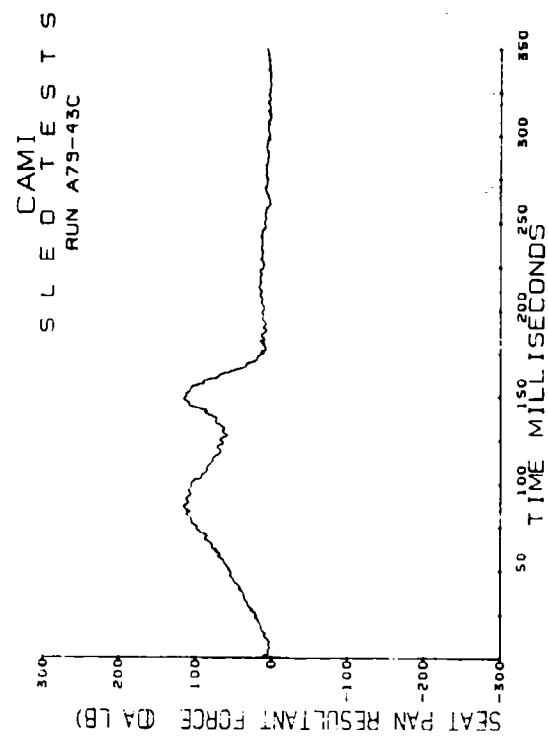
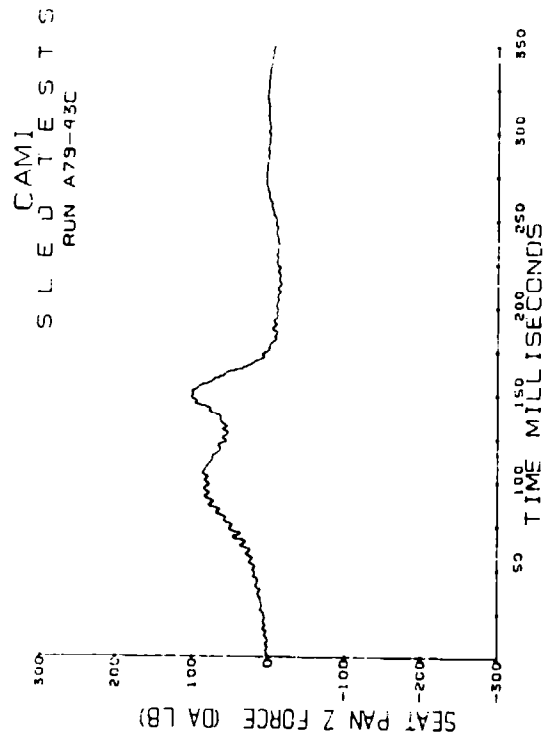
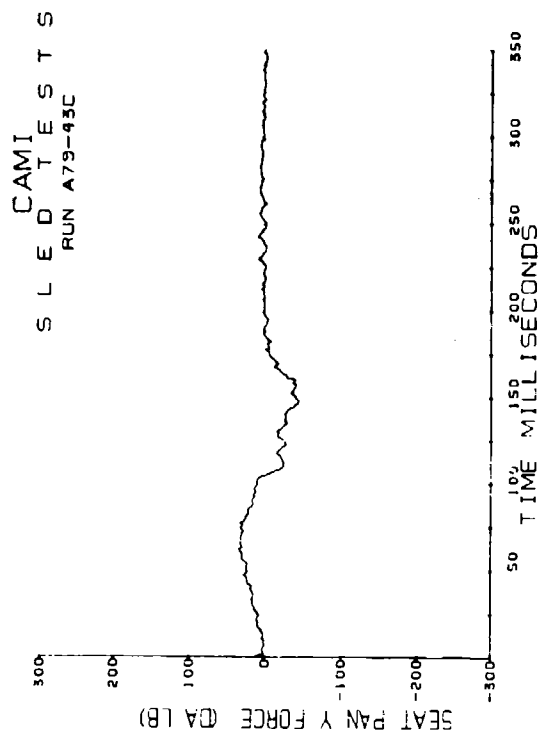
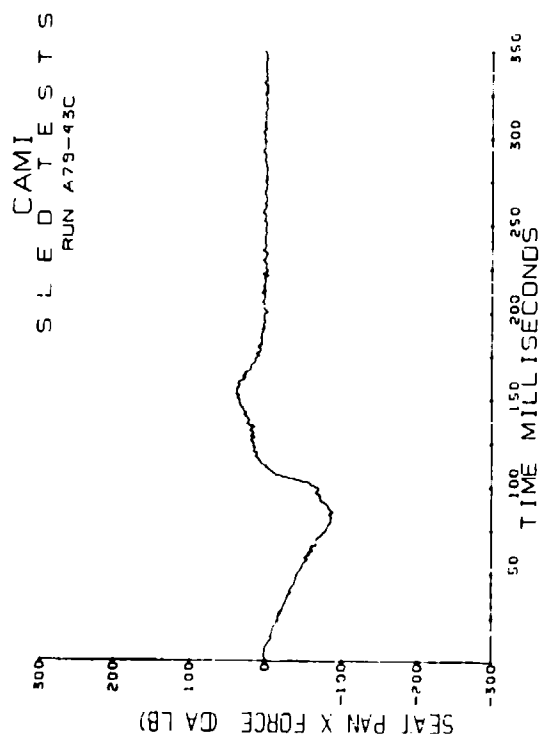
CAMI
S L E D T E S T S
RUN A79-43B



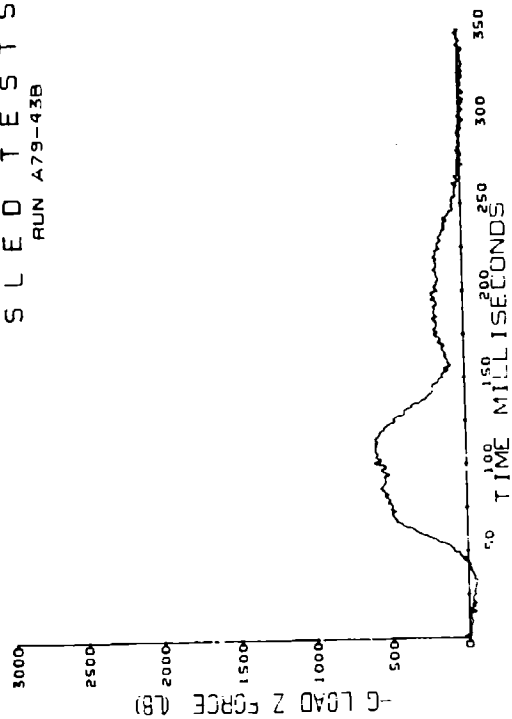
CAMI
S L E D T E S T S
RUN A79-43B



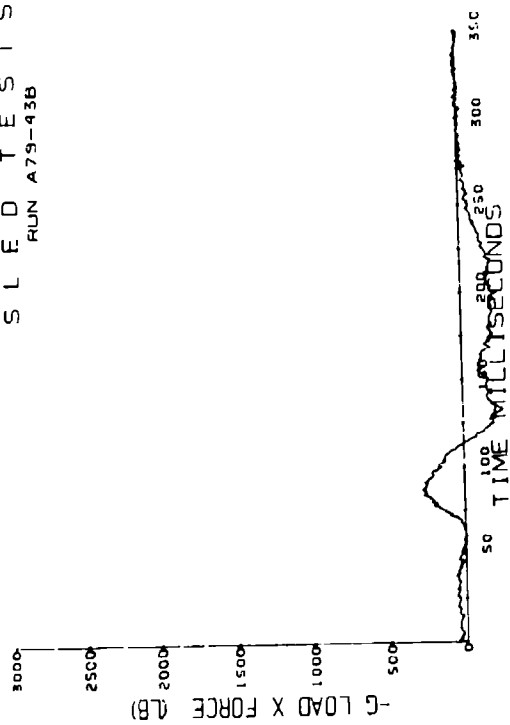




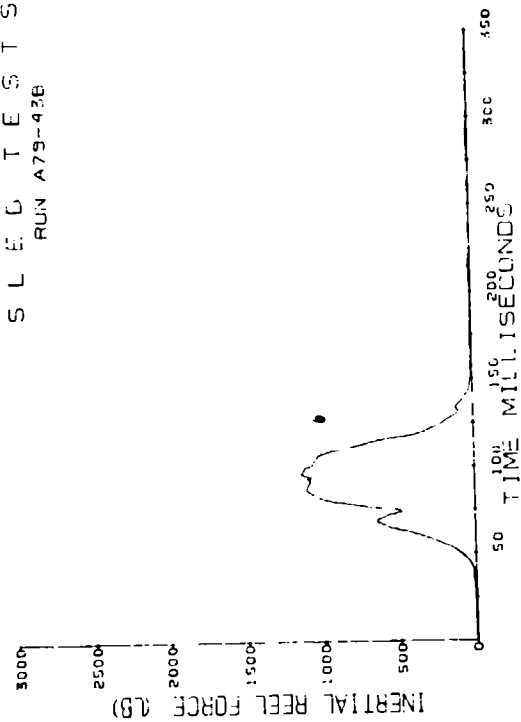
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S L E D T E S T S
RUN A79-43B



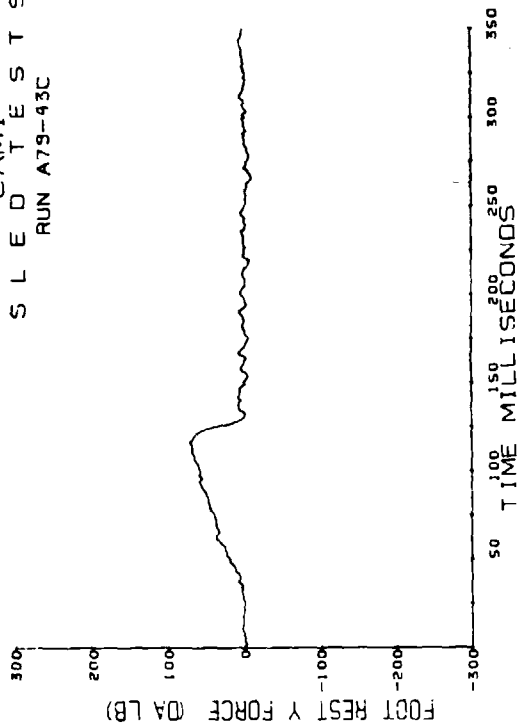
CAMI
S L E D T E S T S
RUN A79-43B



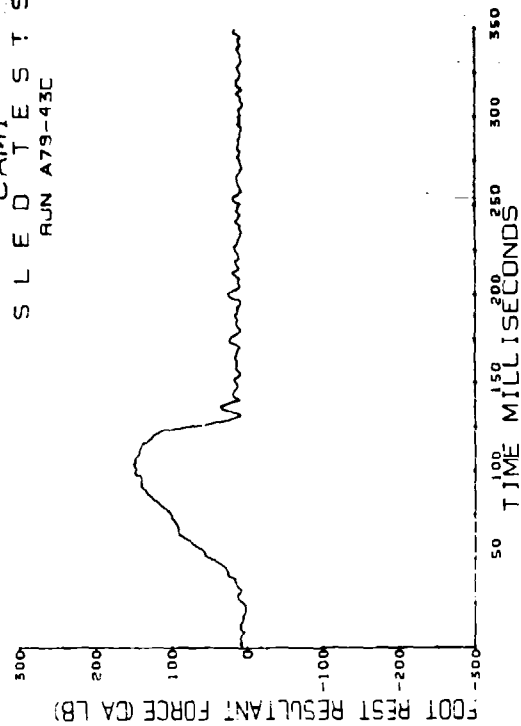
CAMI
S L E D T E S T S
RUN A79-43B



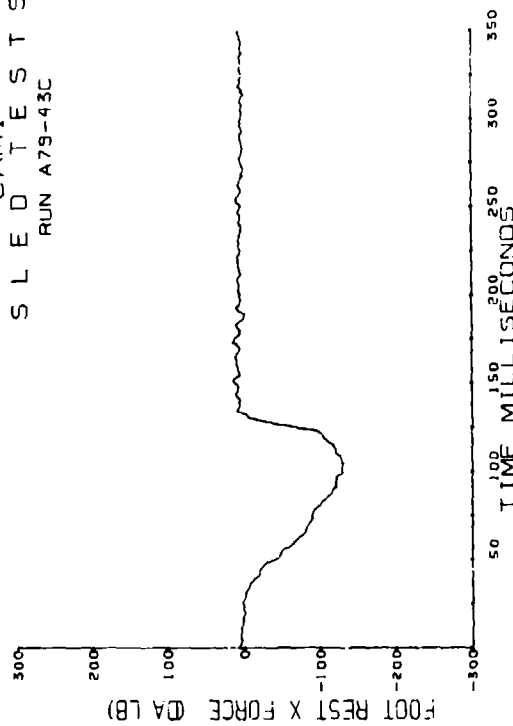
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S L E D T E S T S
RUN A79-43C



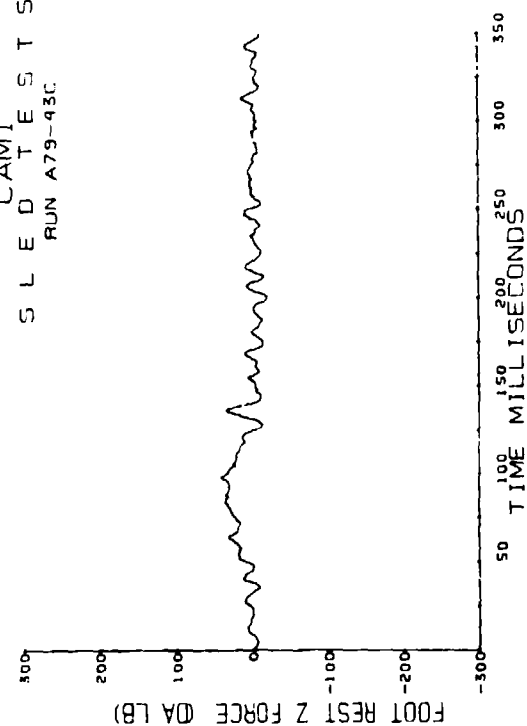
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S L E D T E S T S
RUN A79-43C



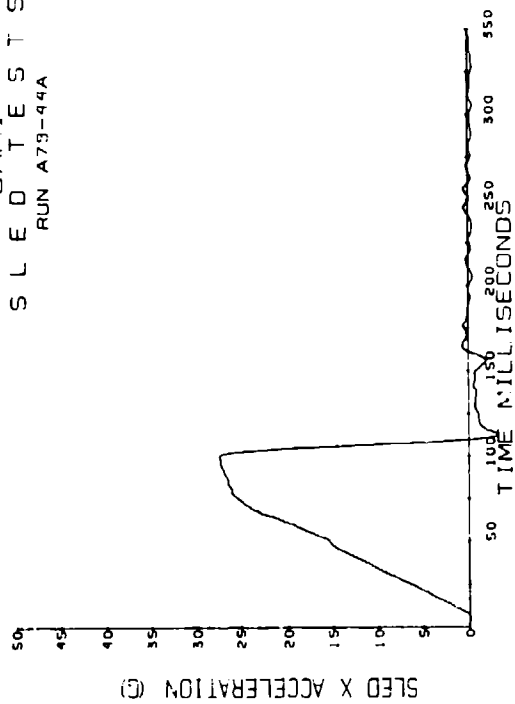
CAMI
S L E D T E S T S
RUN A79-43C



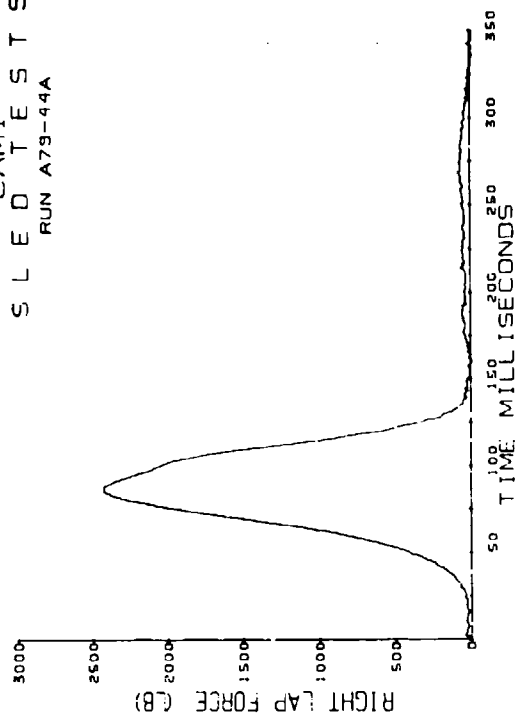
CAMI
S L E D T E S T S
RUN A79-43C



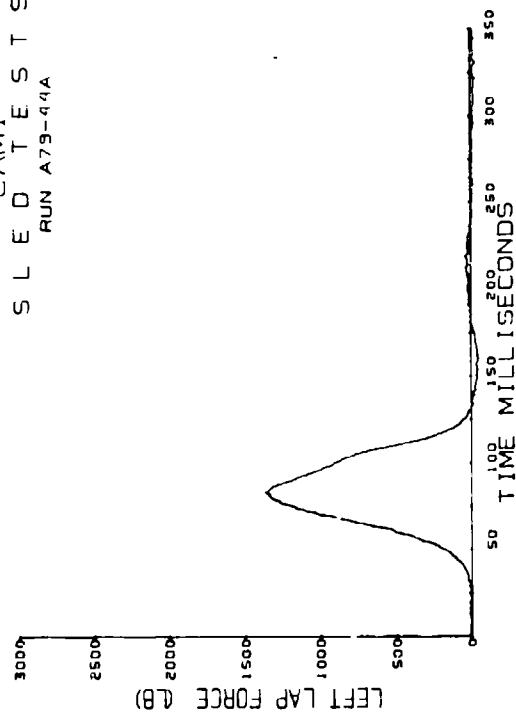
CAMI
S L E D T E S T S
RUN A79-44A



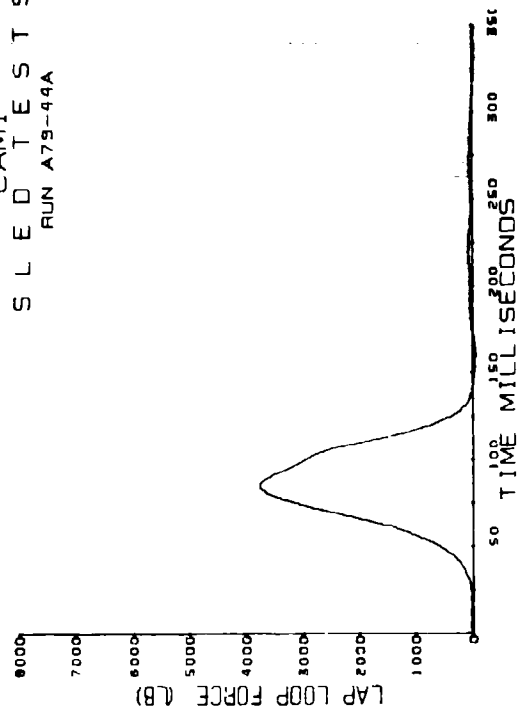
CAMI
S L E D T E S T S
RUN A79-44A



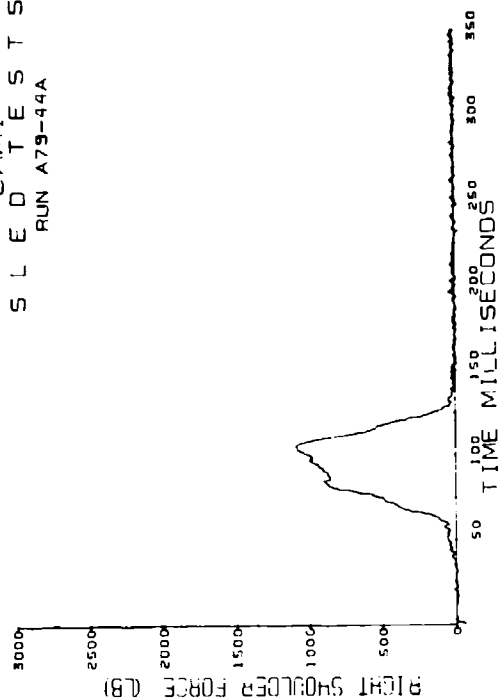
CAMI
S L E D T E S T S
RUN A79-44A



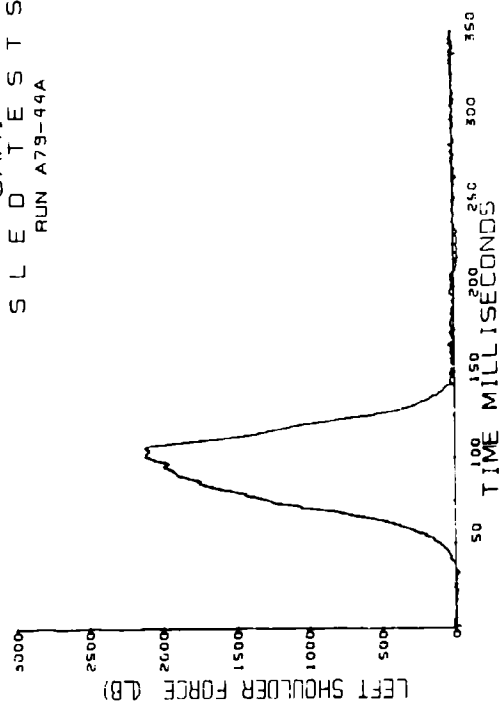
CAMI
S L E D T E S T S
RUN A79-44A



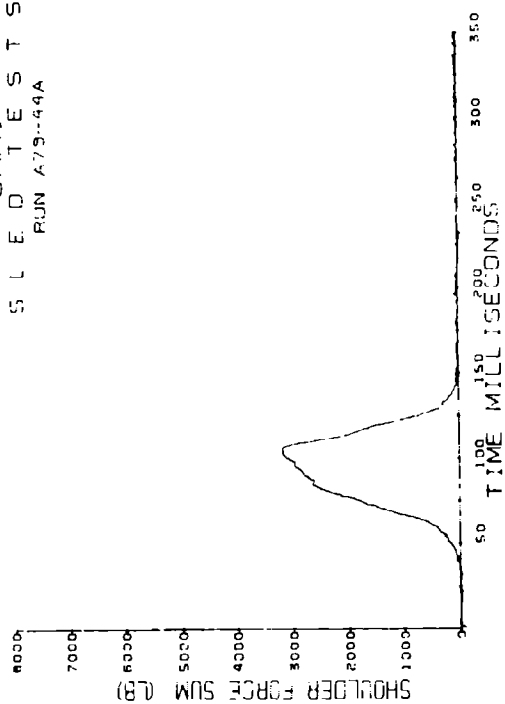
CAMI
S L E D T E S T S
RUN A79-44A

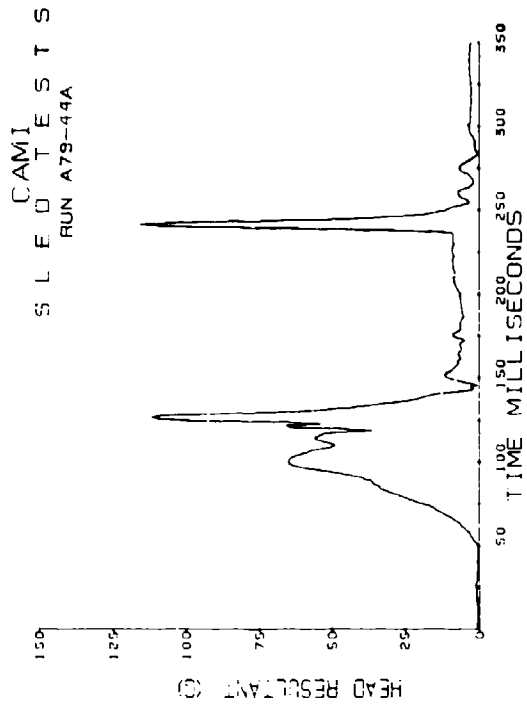
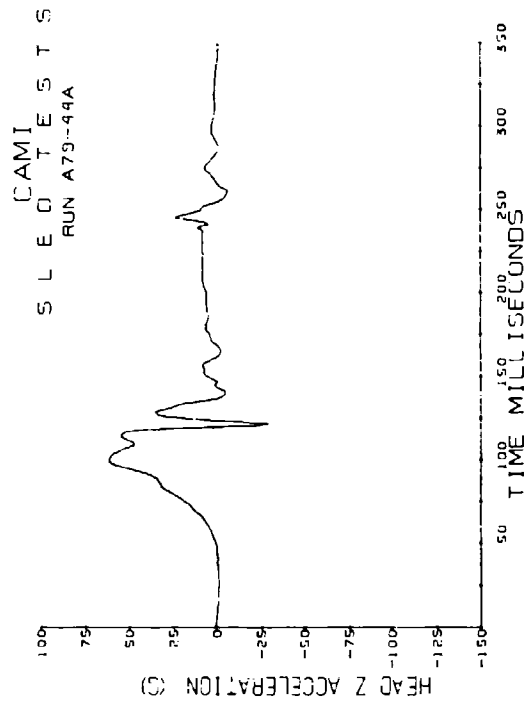
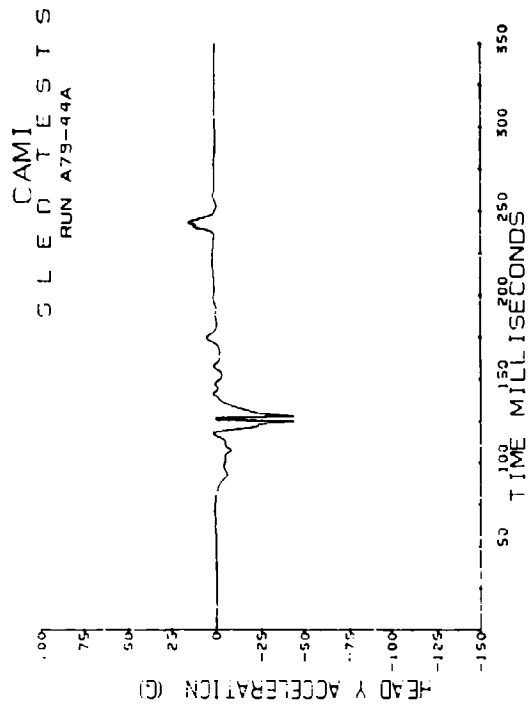
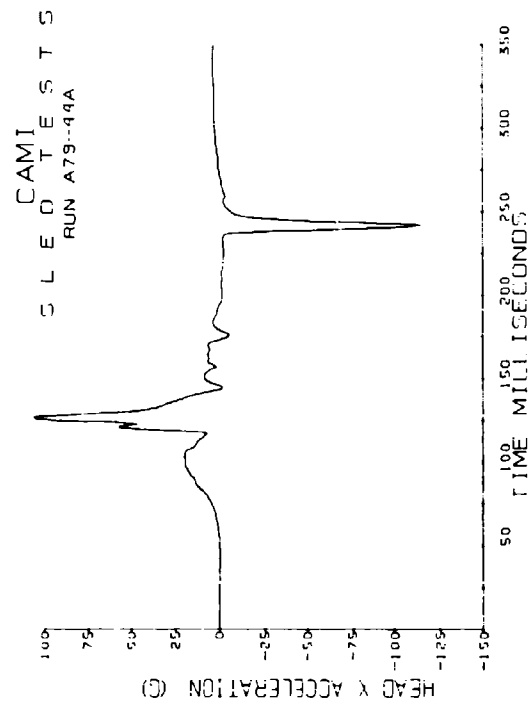


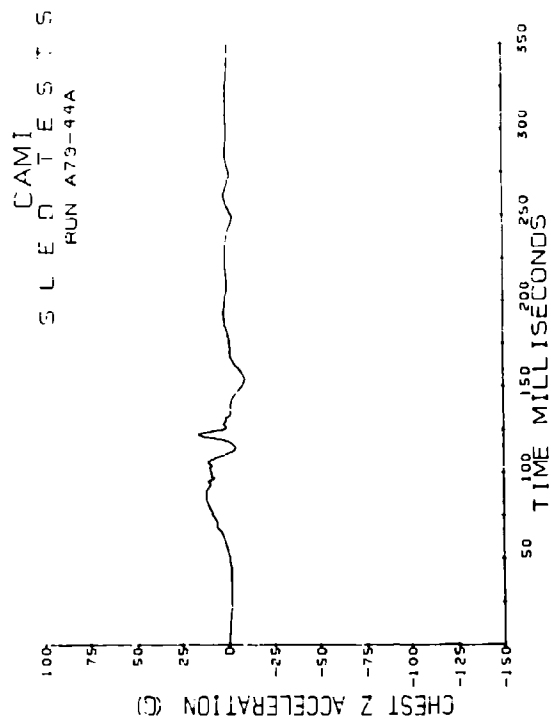
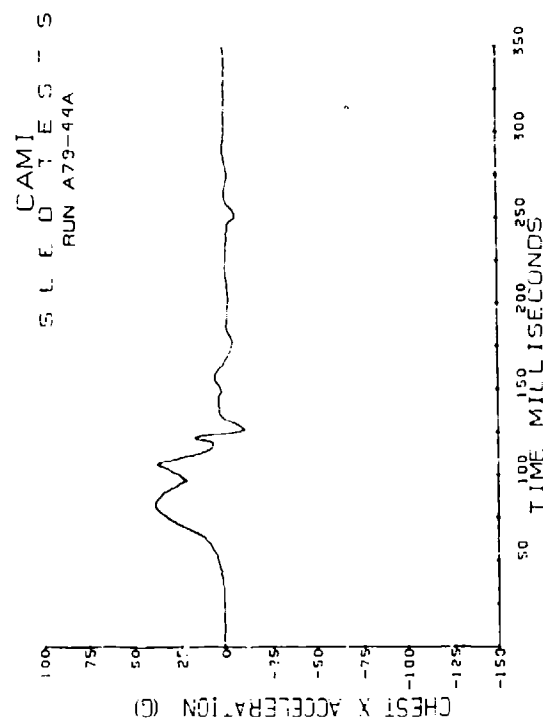
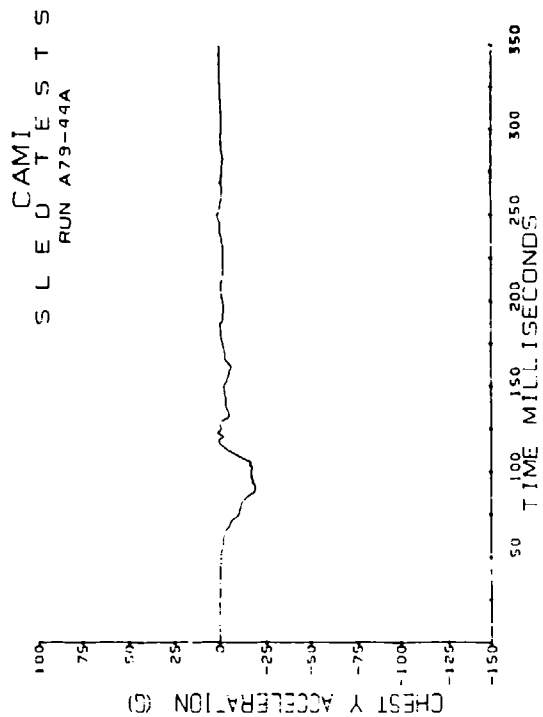
CAMI
S L E D T E S T S
RUN A79-44A



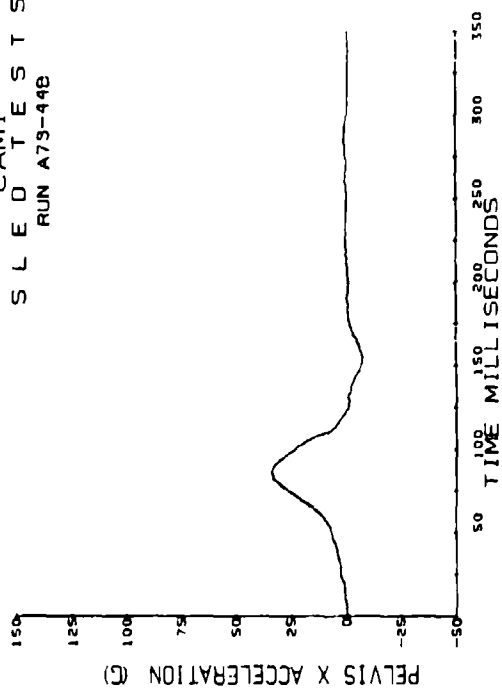
CAMI
S L E D T E S T S
RUN A79-44A



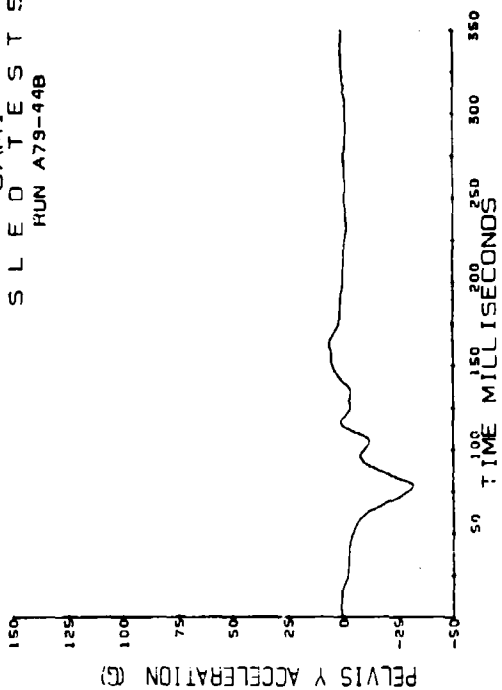




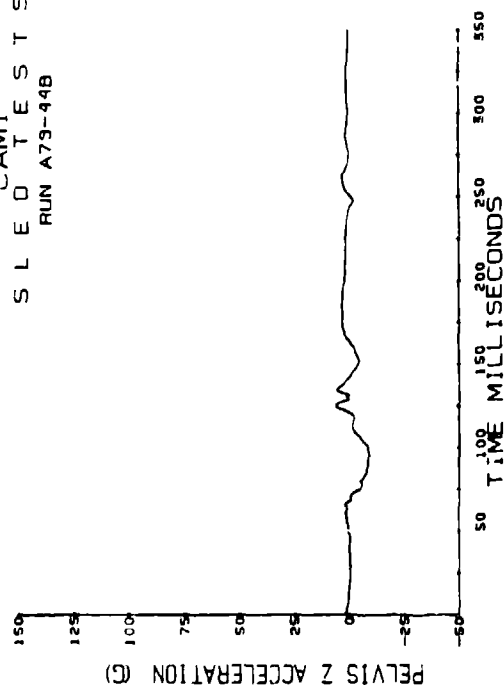
CAMI
S L E D T E S T S
RUN A79-44B



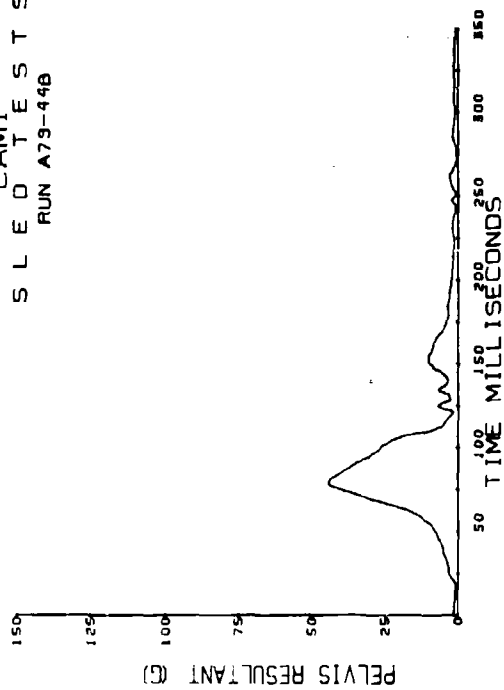
CAMI
S L E D T E S T S
RUN A79-44B

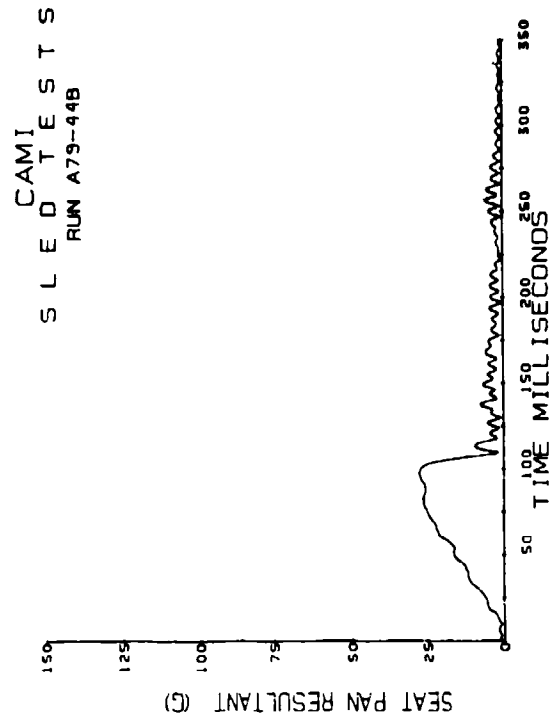
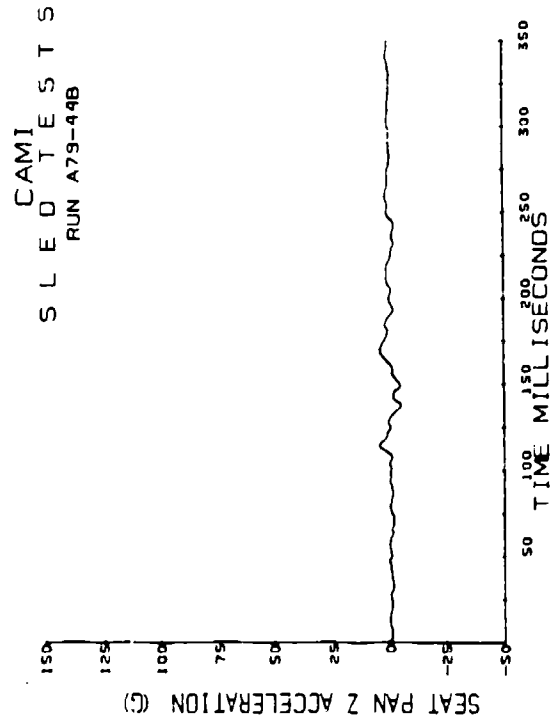
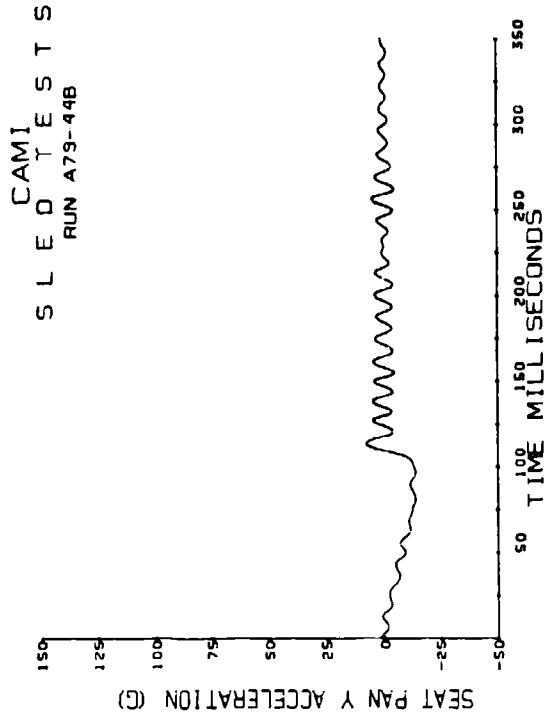
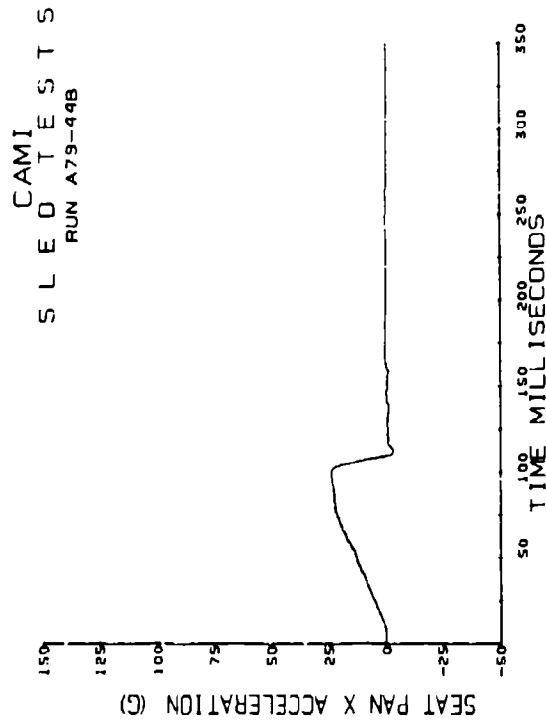


CAMI
S L E D T E S T S
RUN A79-44B

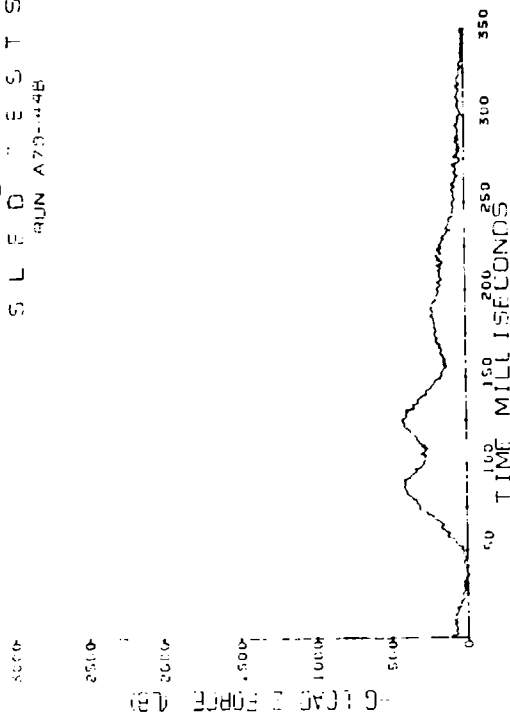


CAMI
S L E D T E S T S
RUN A79-44B

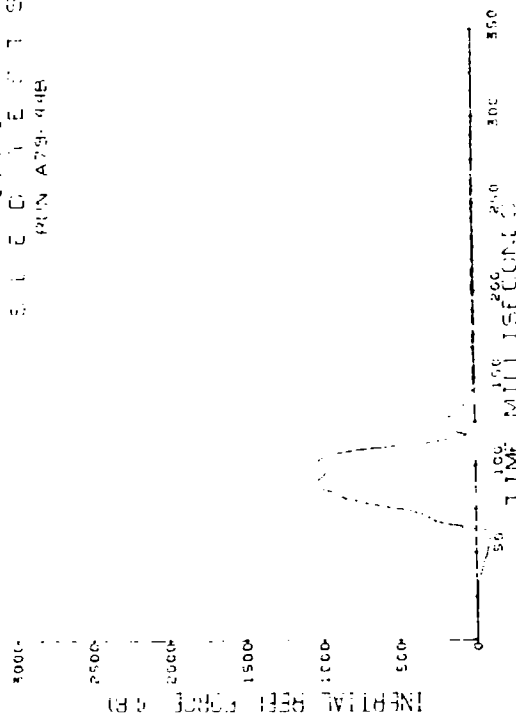




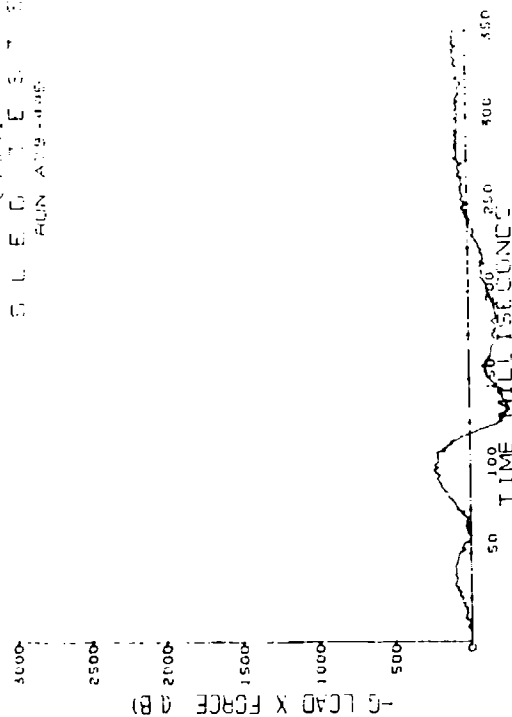
CAMI
S L E D E S T S
RUN A79-44B



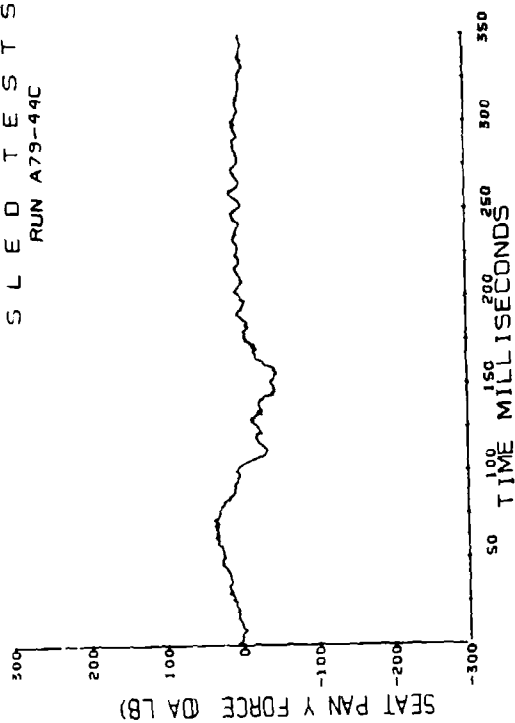
CAMI
S L E D E S T S
RUN A79-44B



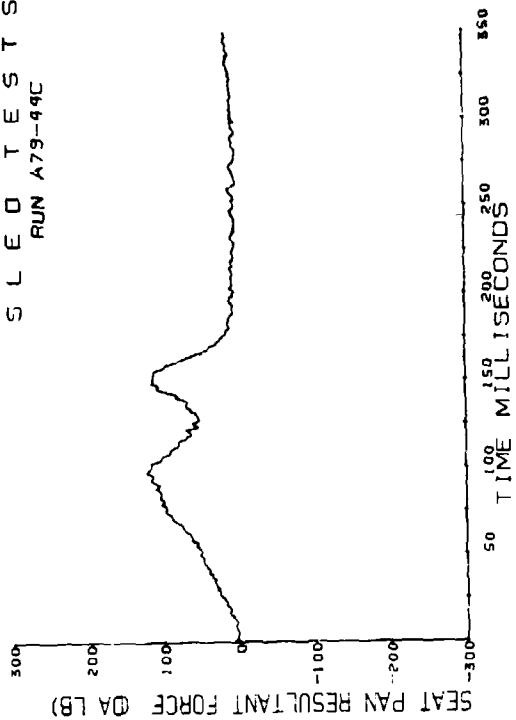
CAMI
S L E D E S T S
RUN A79-44B



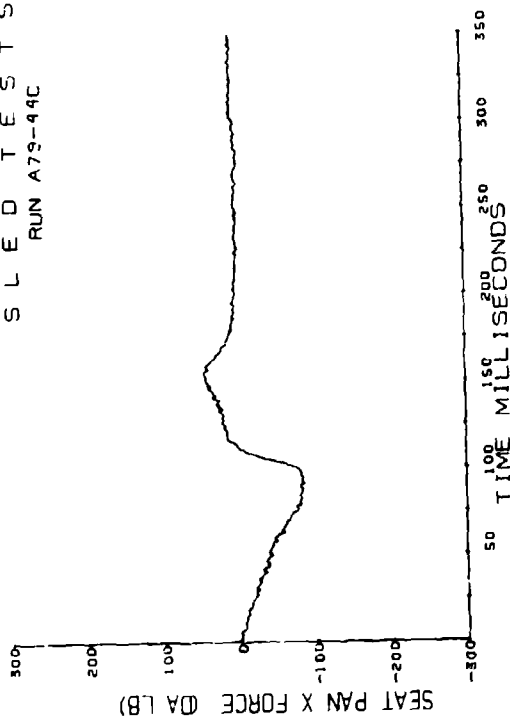
CAMI
S L E D T E S T S
RUN A79-44C



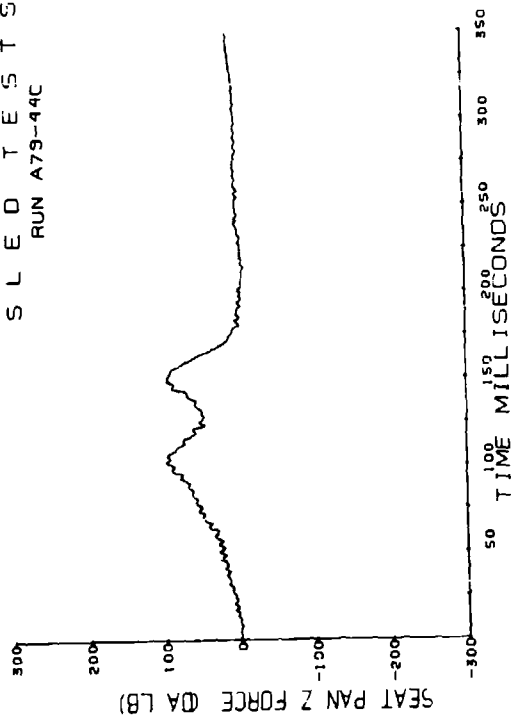
CAMI
S L E D T E S T S
RUN A79-44C



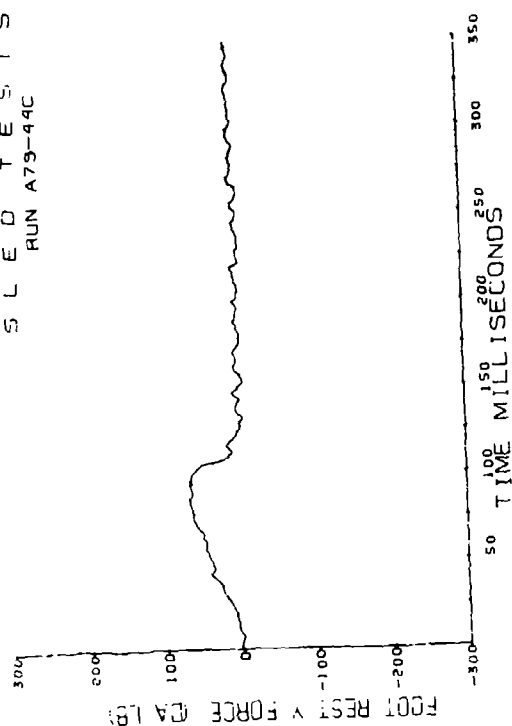
CAMI
S L E D T E S T S
RUN A79-44C



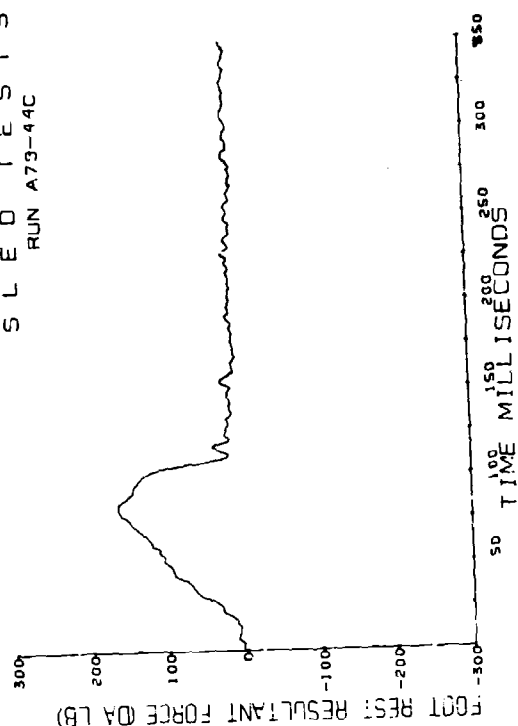
CAMI
S L E D T E S T S
RUN A79-44C



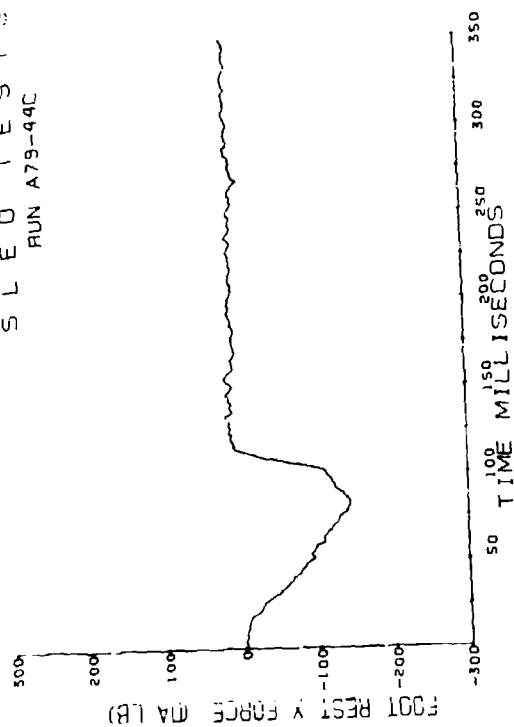
CAMI
S L E D T E S T S
RUN A79-44C



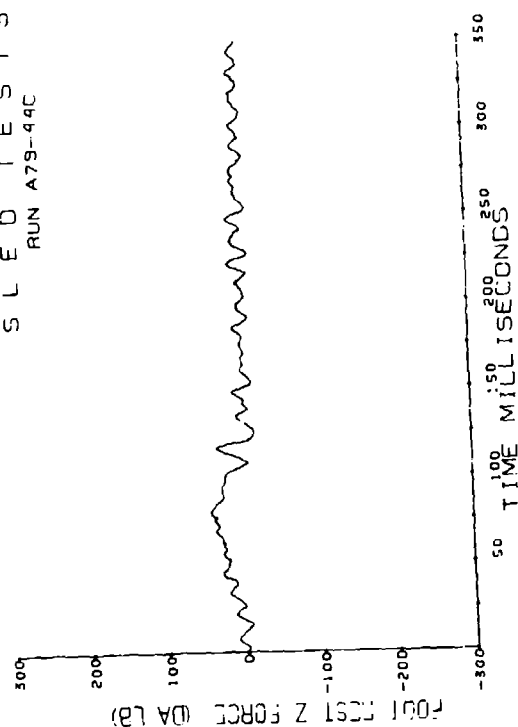
CAMI
S L E D T E S T S
RUN A79-44C

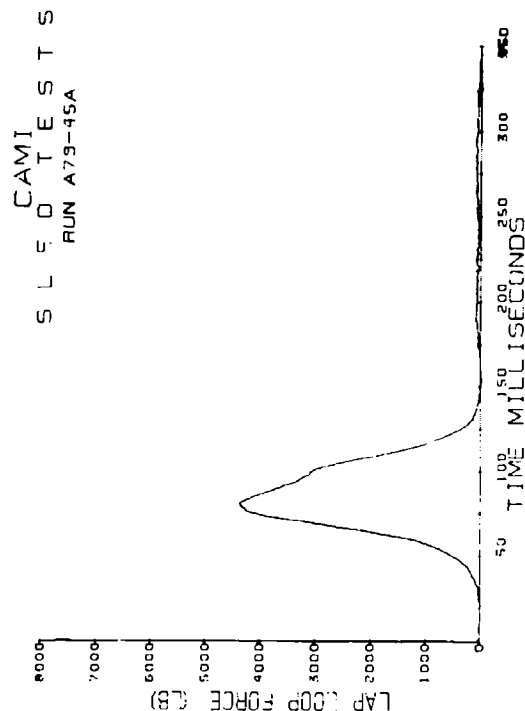
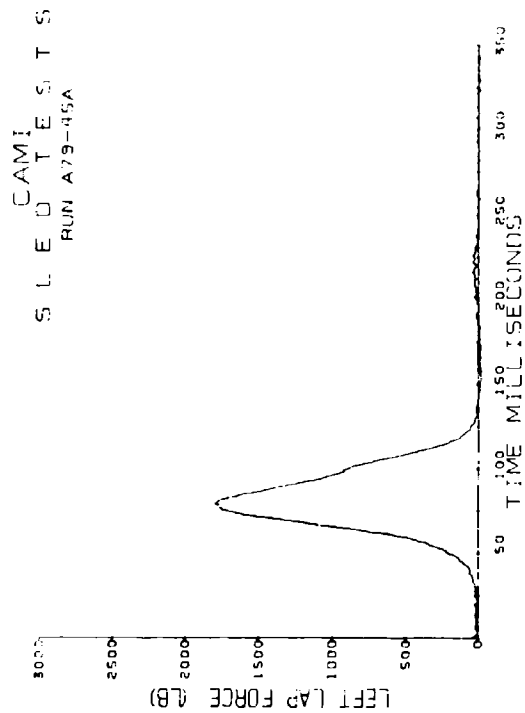
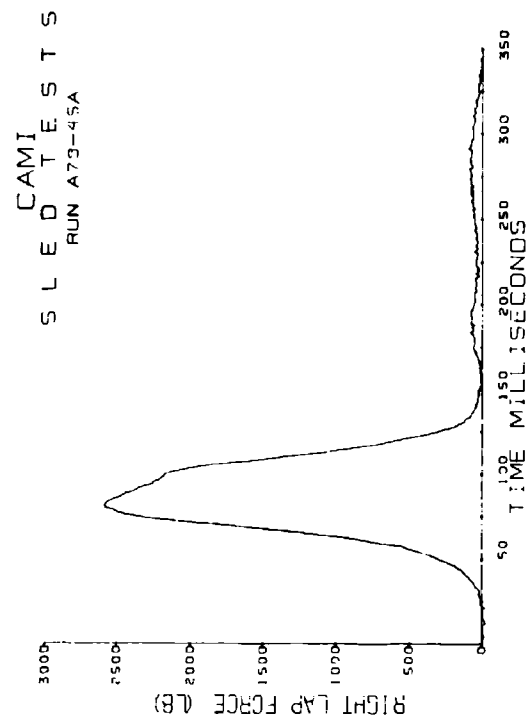
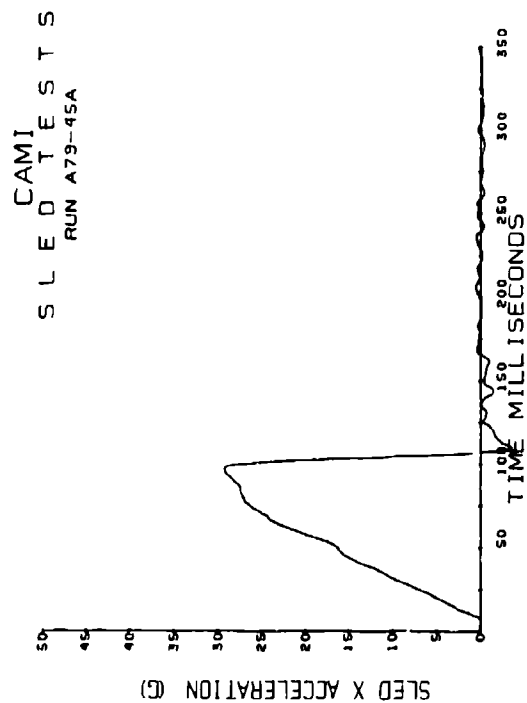


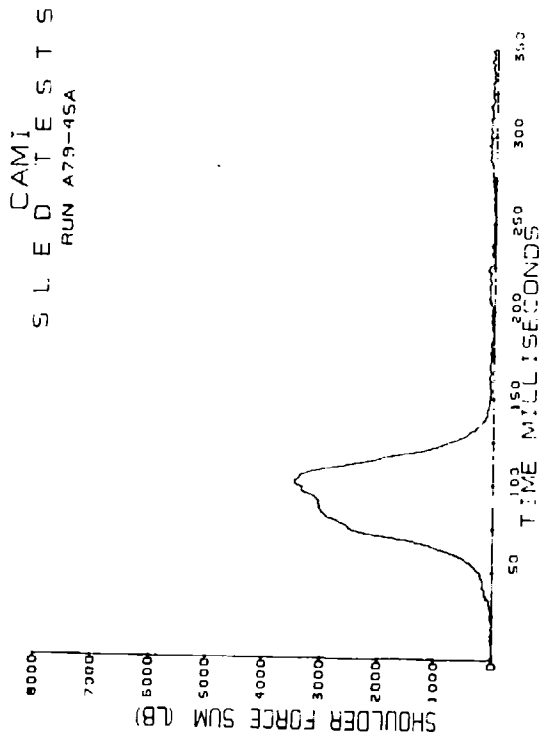
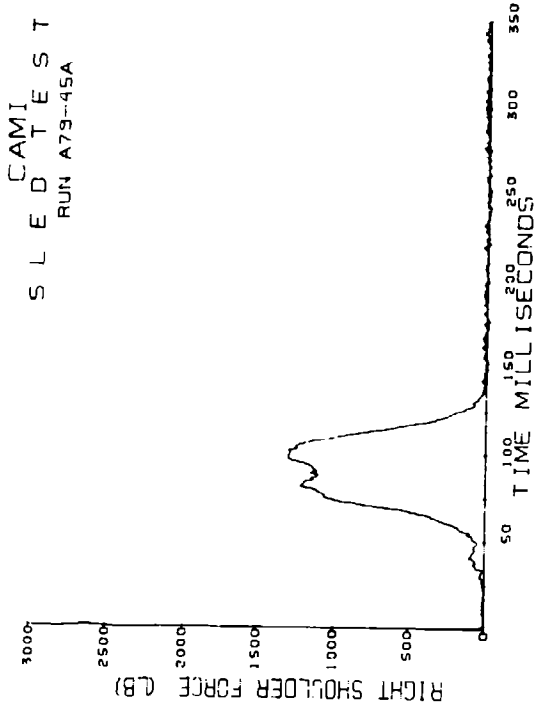
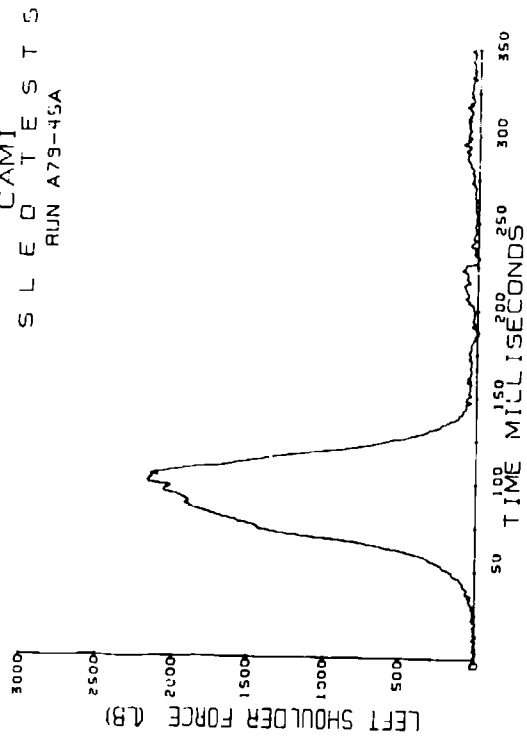
CAMI
S L E D T E S T S
RUN A79-44C

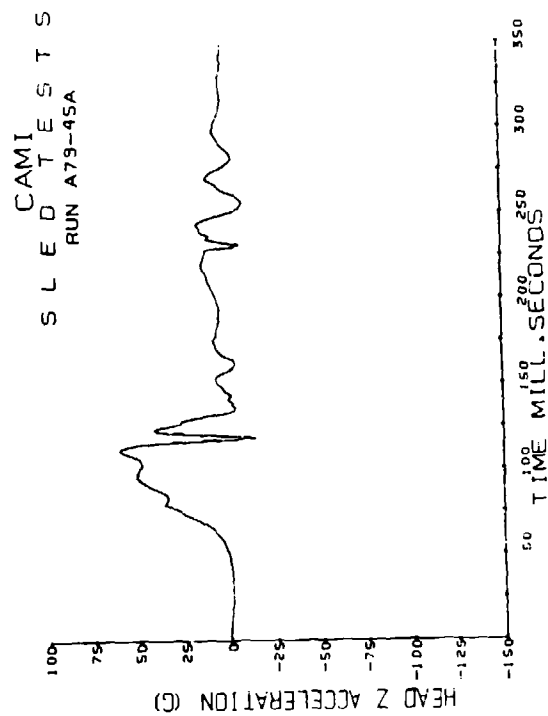
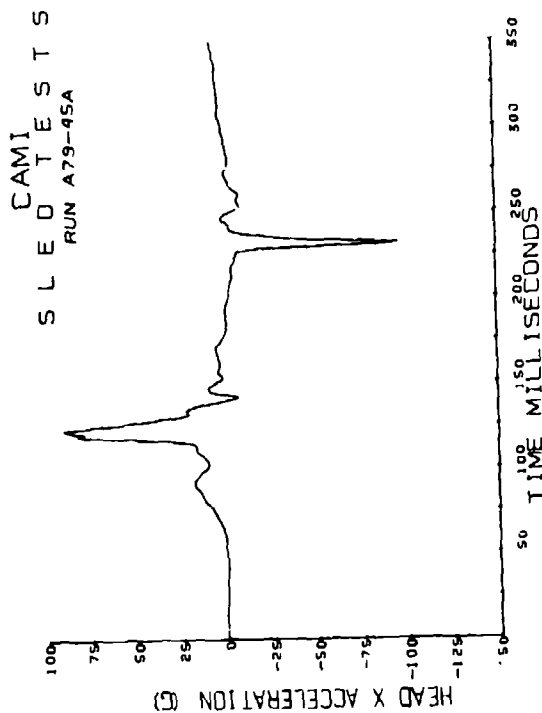
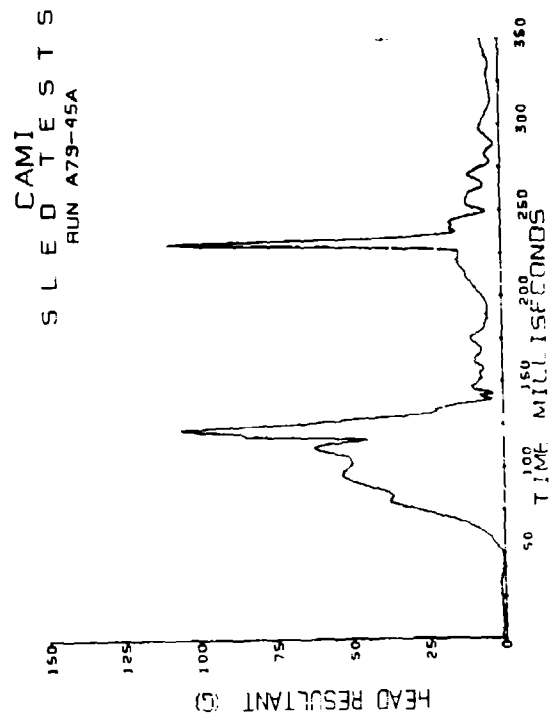
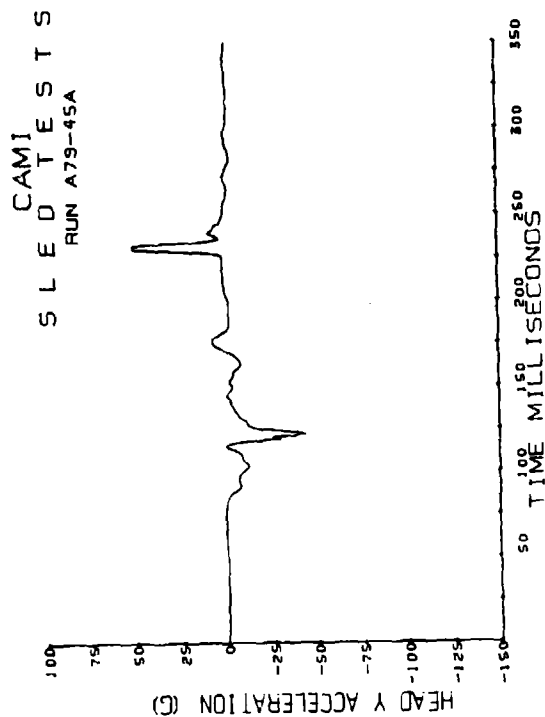


CAMI
S L E D T E S T S
RUN A79-44C

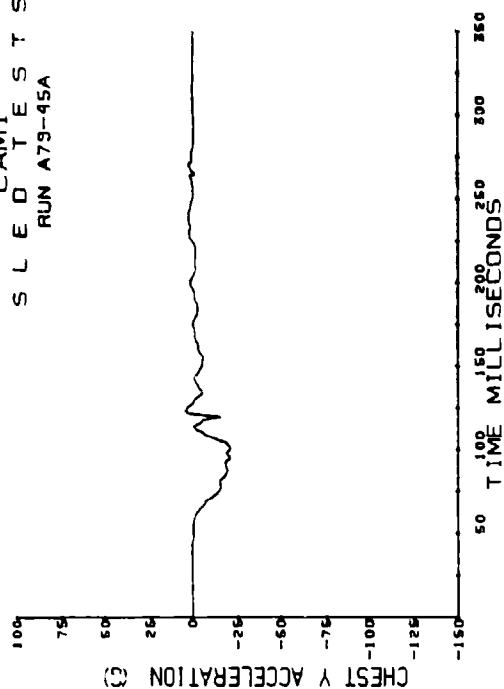




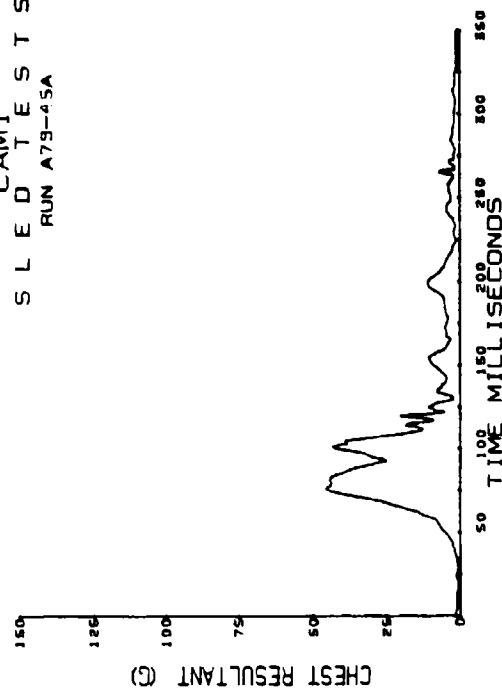




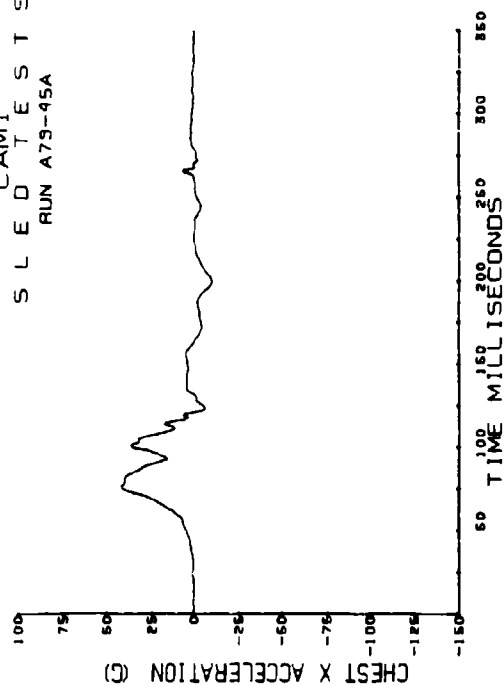
CAMI
SLED TESTS
RUN A79-45A



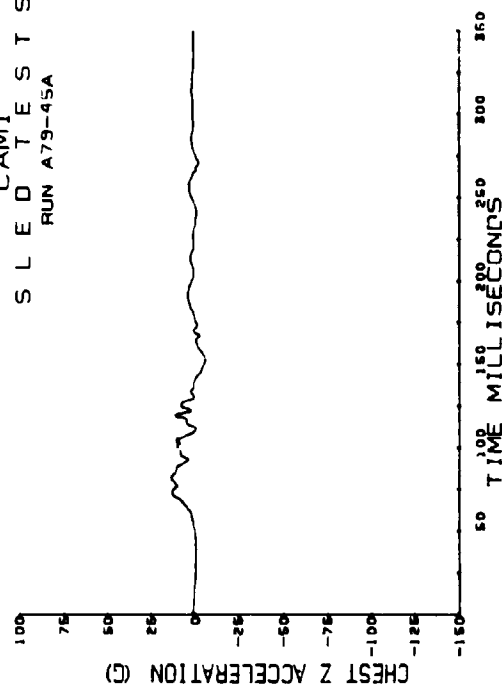
CAMI
SLED TESTS
RUN A79-45A



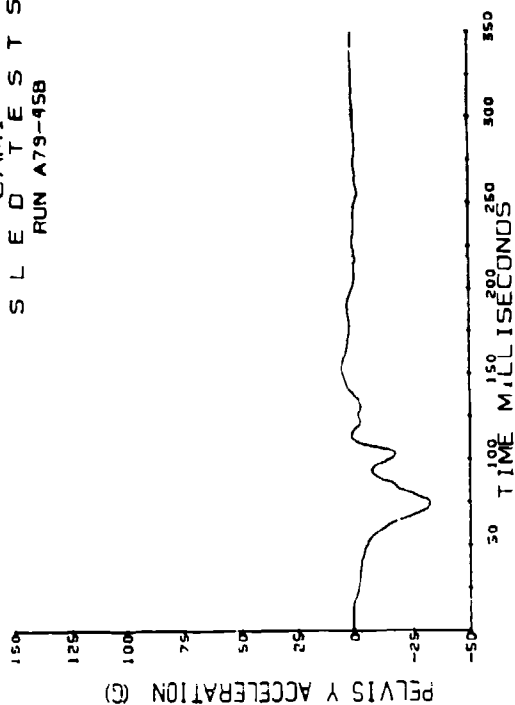
CAMI
SLED TESTS
RUN A79-45A



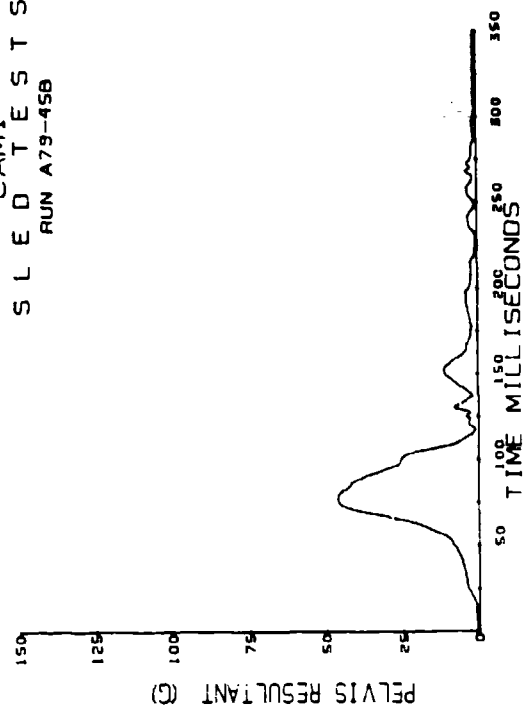
CAMI
SLED TESTS
RUN A79-45A



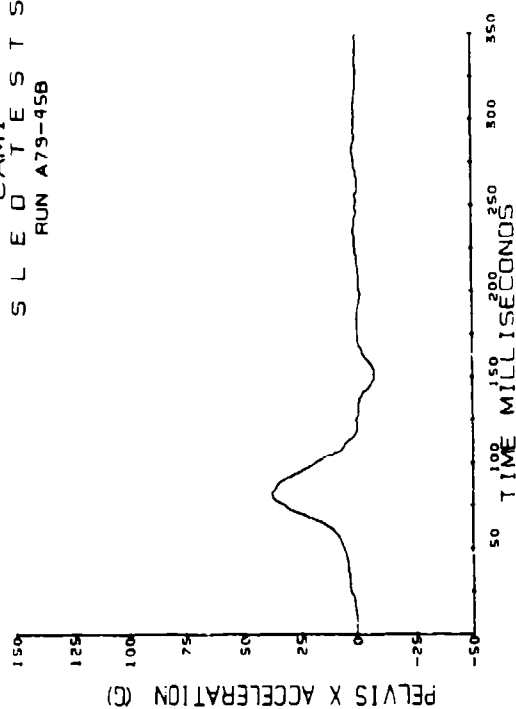
CAMI
S L E D T E S T S
RUN A79-45B



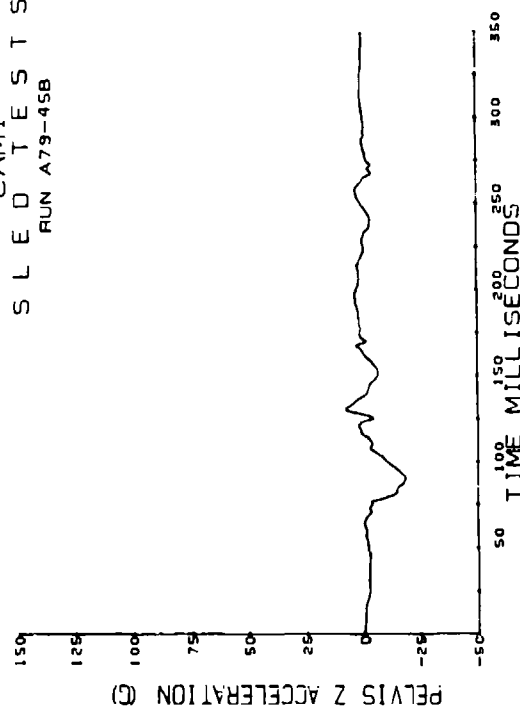
CAMI
S L E D T E S T S
RUN A79-45B



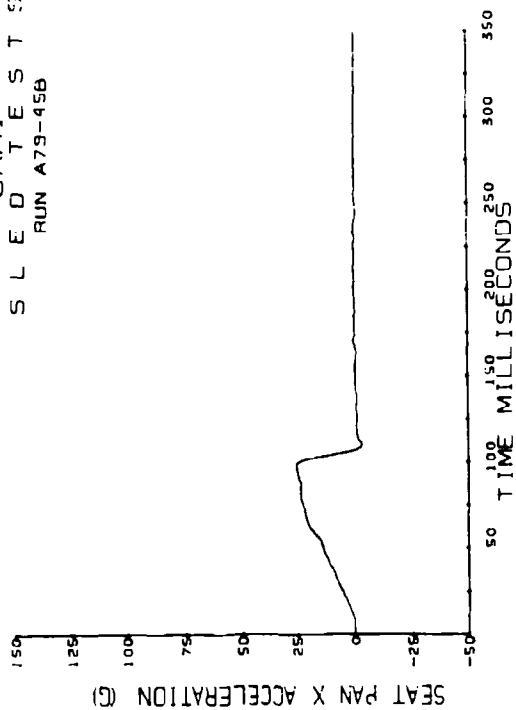
CAMI
S L E D T E S T S
RUN A79-45B



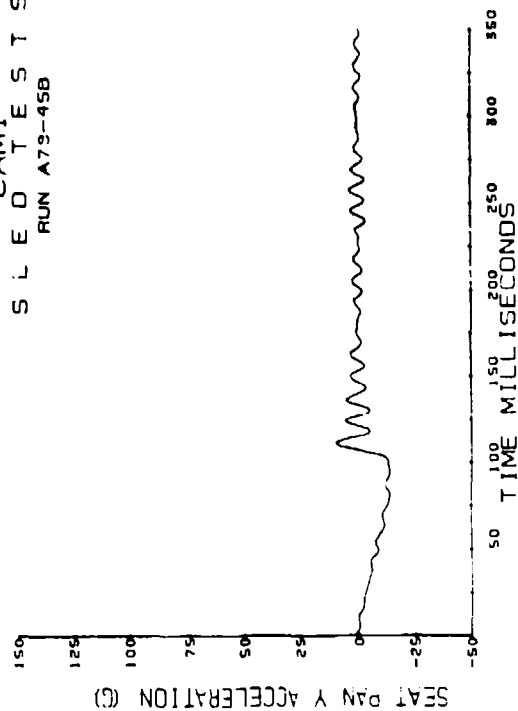
CAMI
S L E D T E S T S
RUN A79-45B



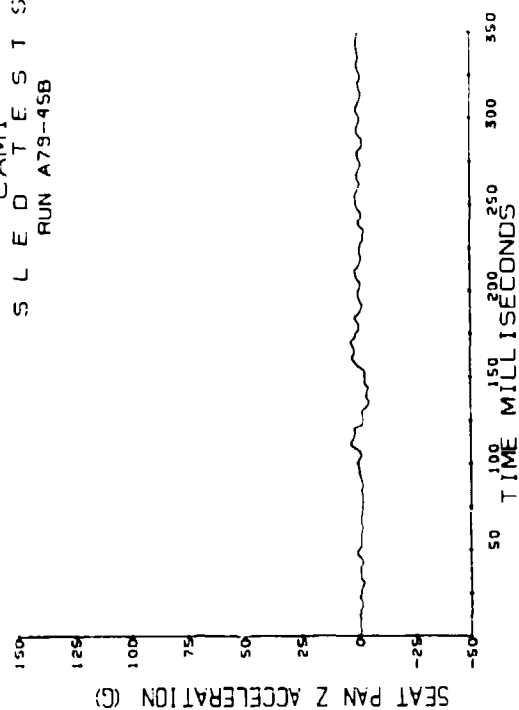
CAMI
S L E D T E S T S
RUN A79-45B



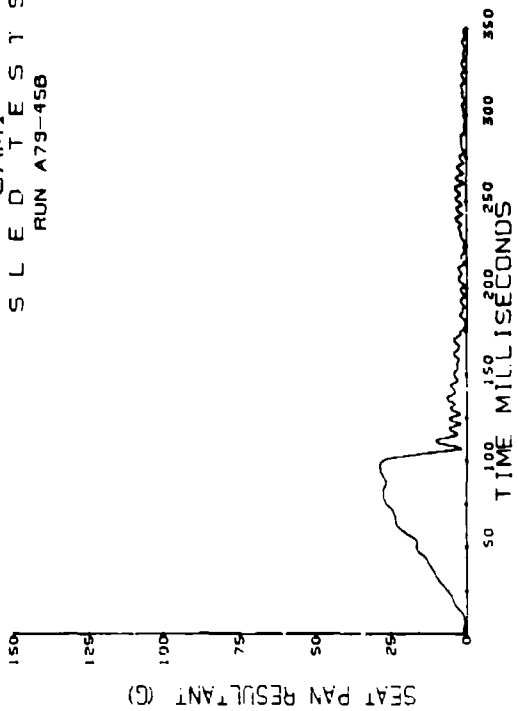
CAMI
S L E D T E S T S
RUN A79-45B



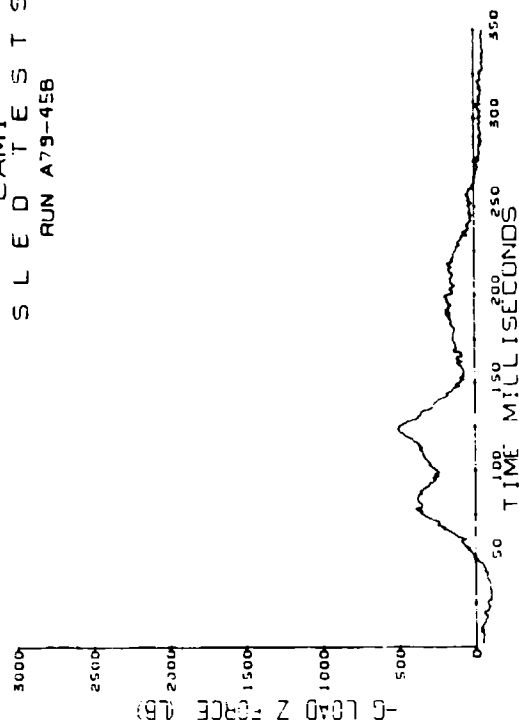
CAMI
S L E D T E S T S
RUN A79-45B



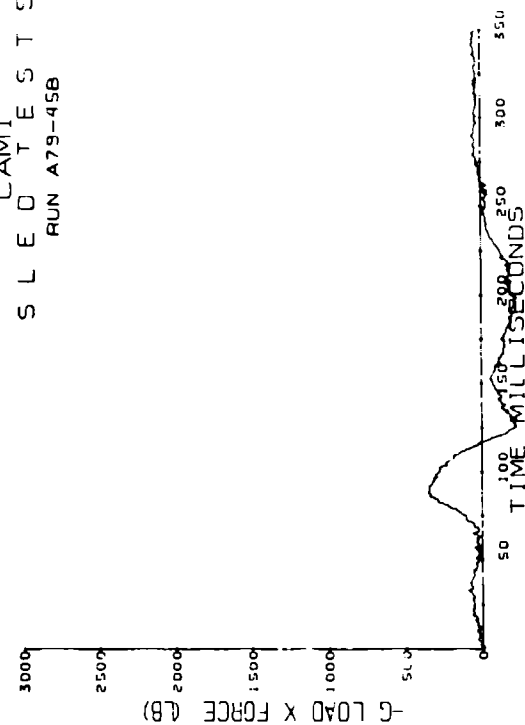
CAMI
S L E D T E S T S
RUN A79-45B



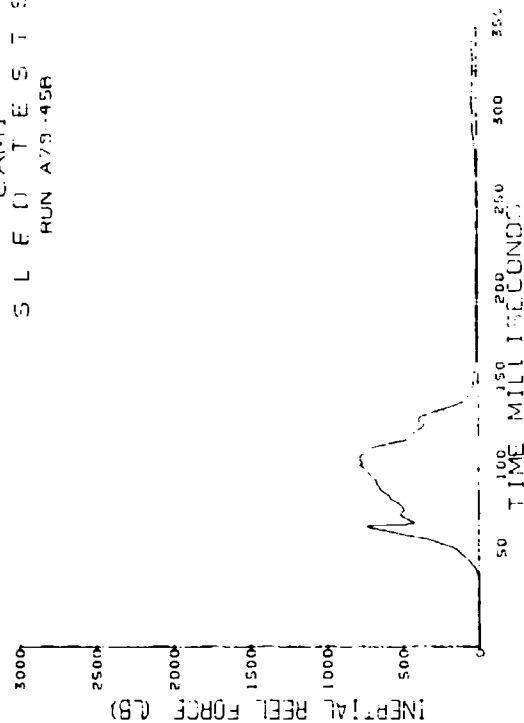
CAMI
S L E D T E S T S
RUN A79-45B

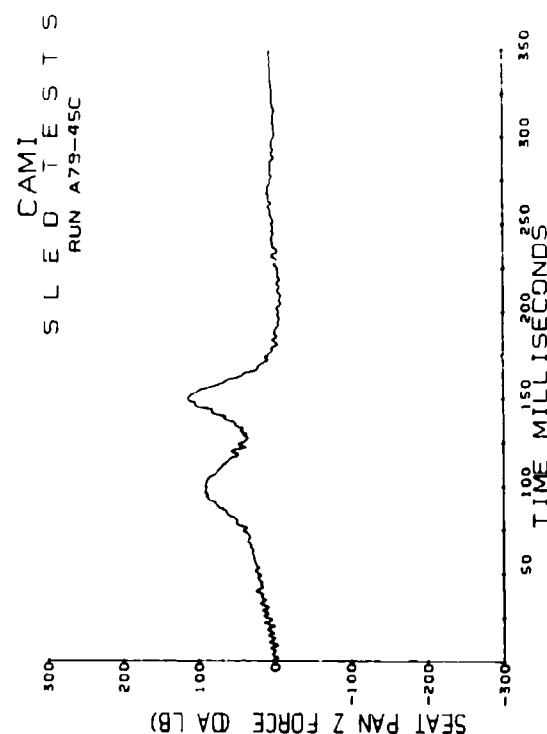
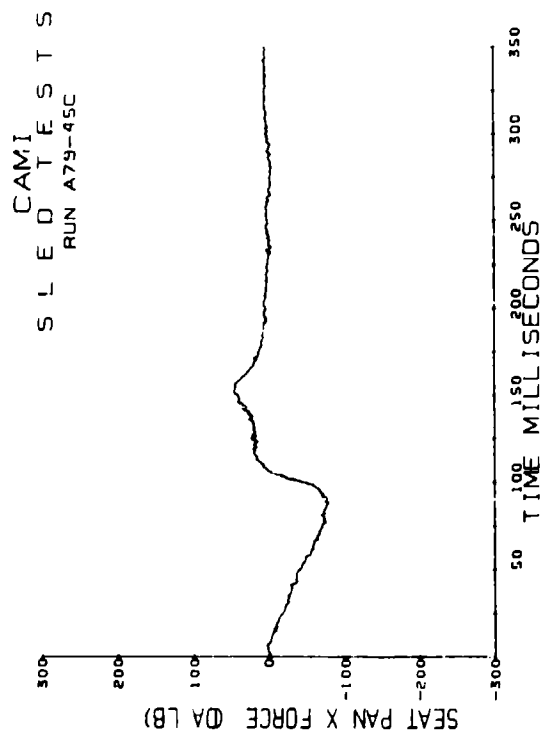
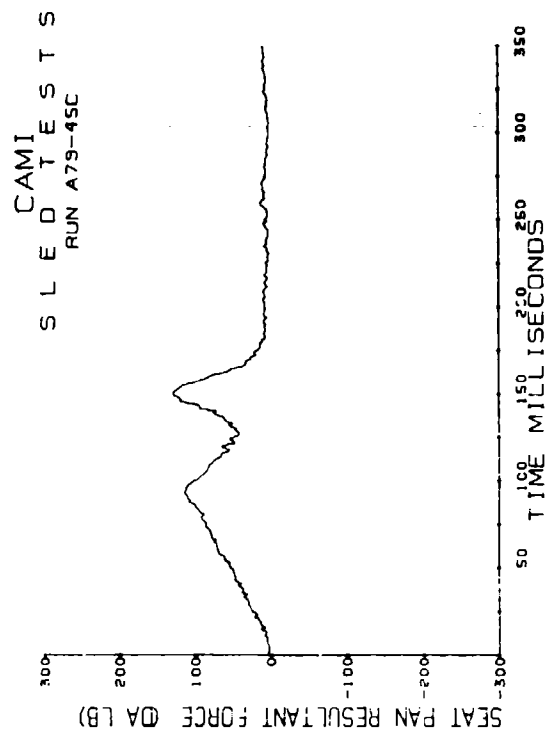
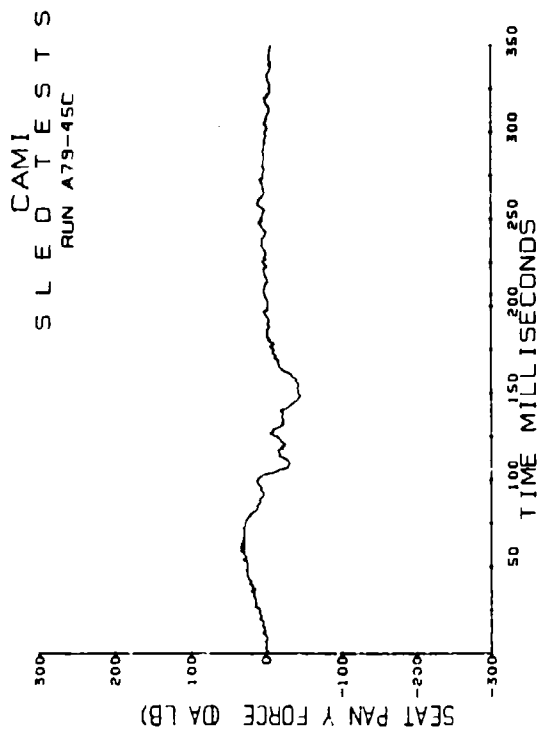


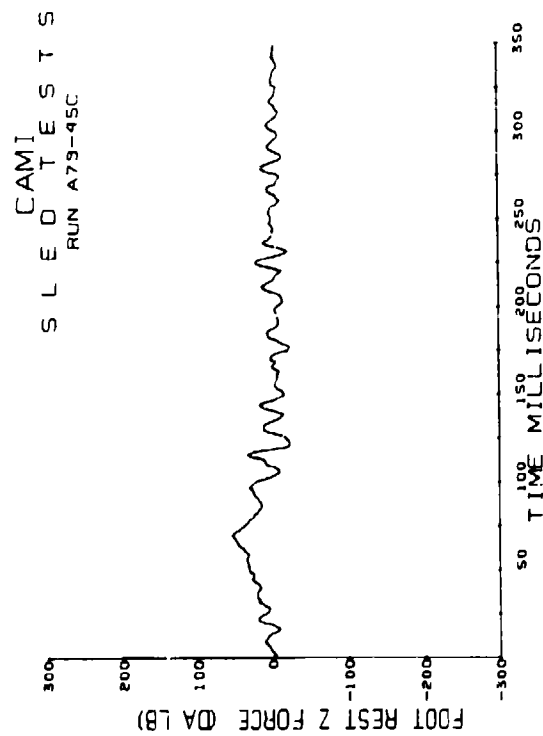
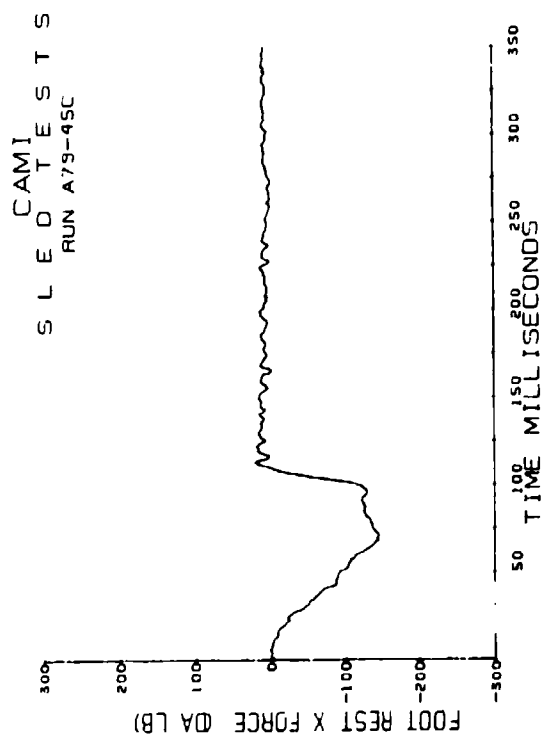
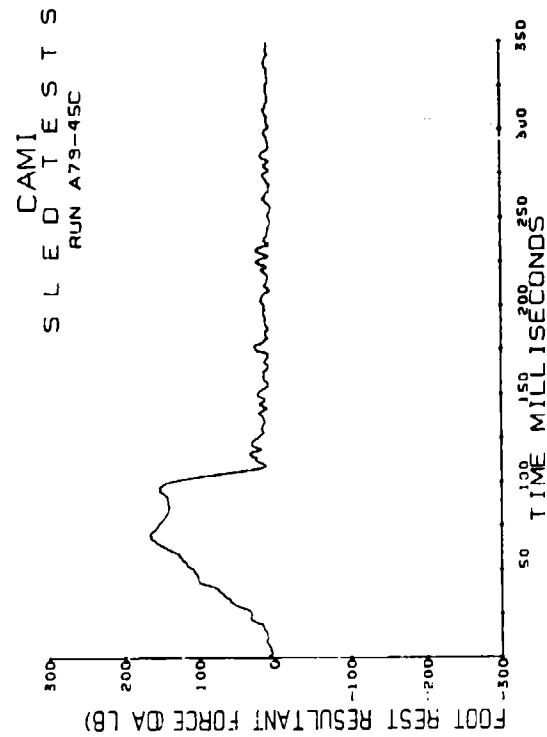
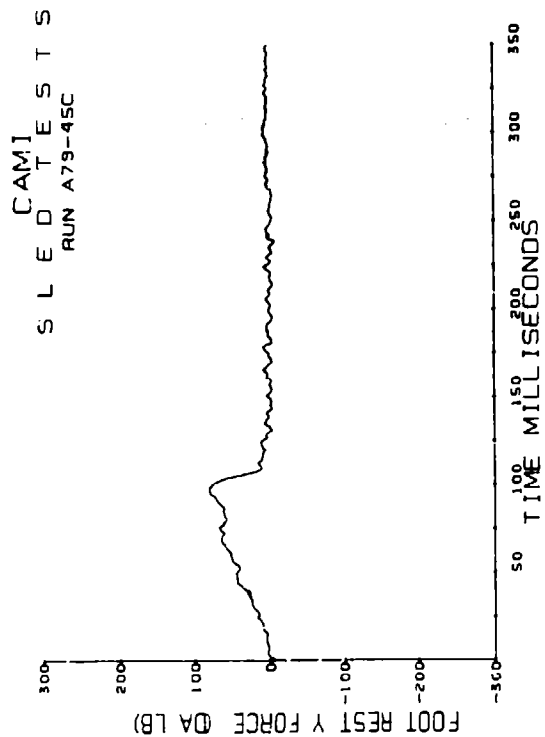
CAMI
S L E D T E S T S
RUN A79-45B

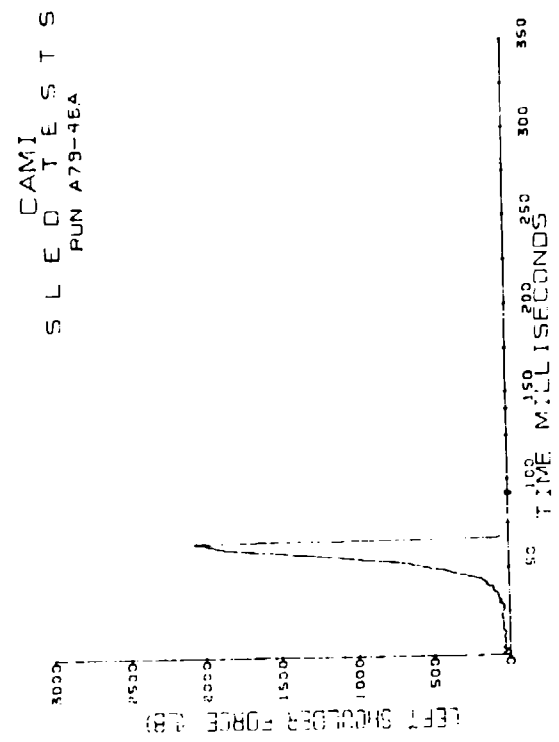
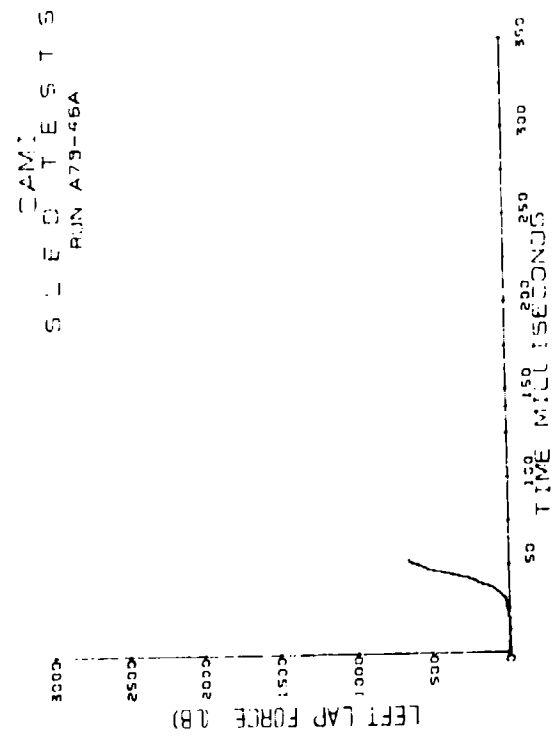
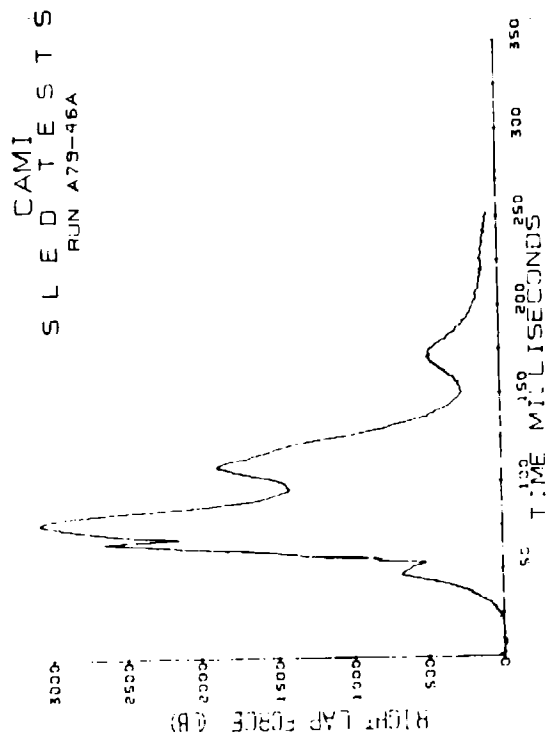
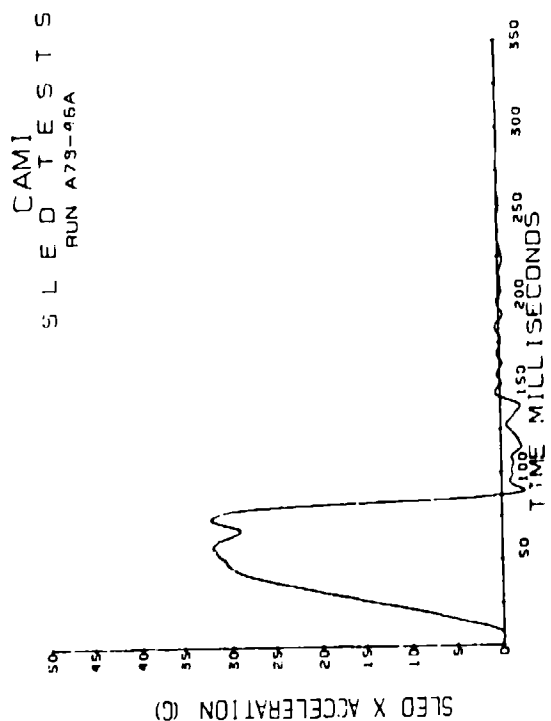


CAMI
S L E D T E S T S
RUN A79-45B

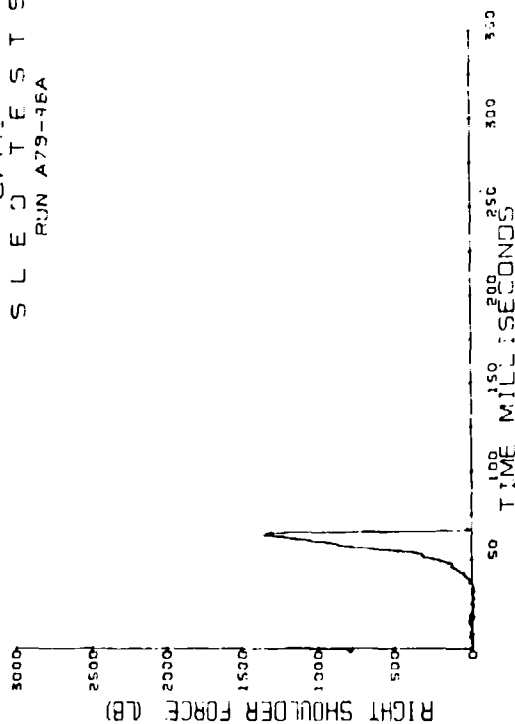




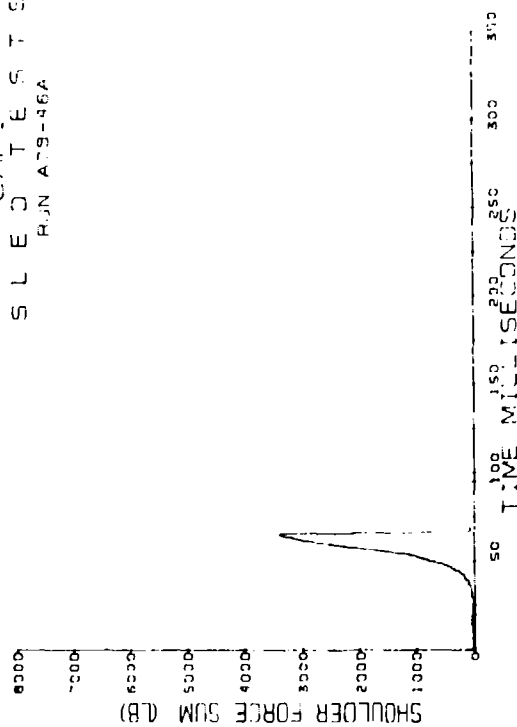


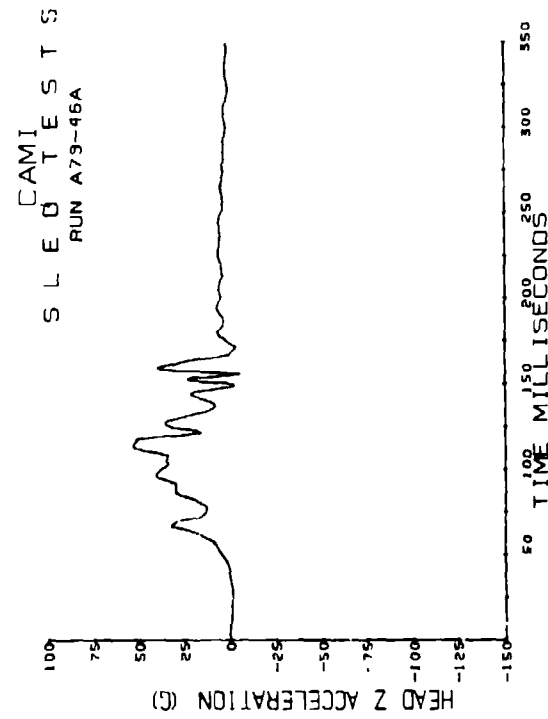
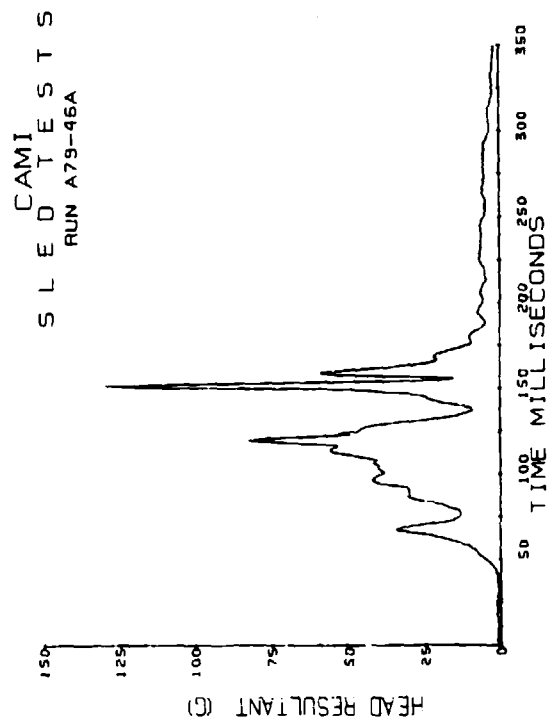
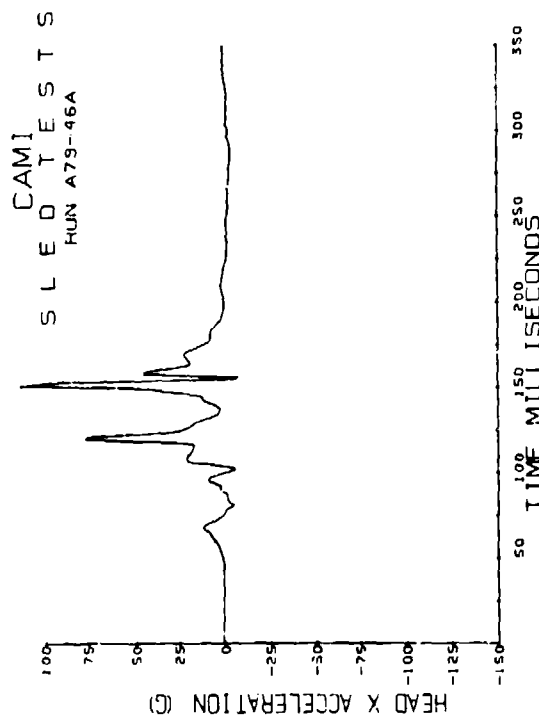
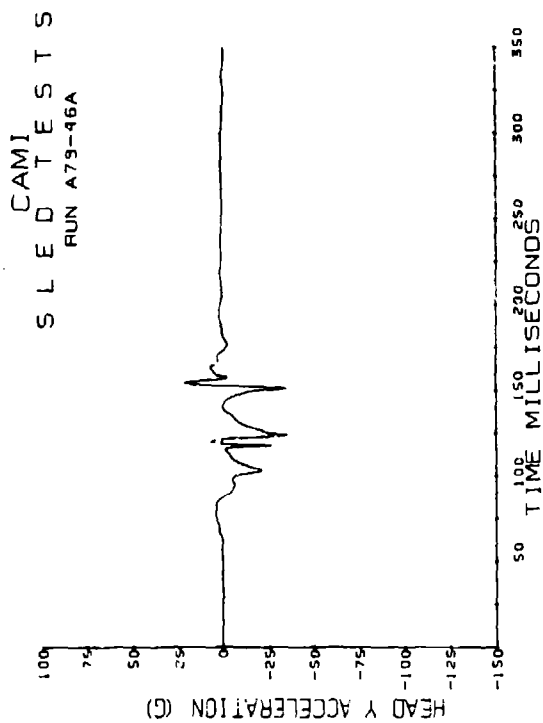


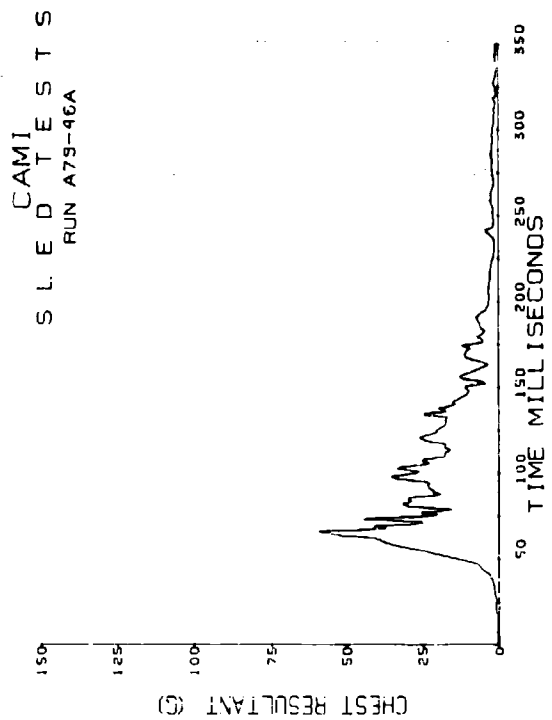
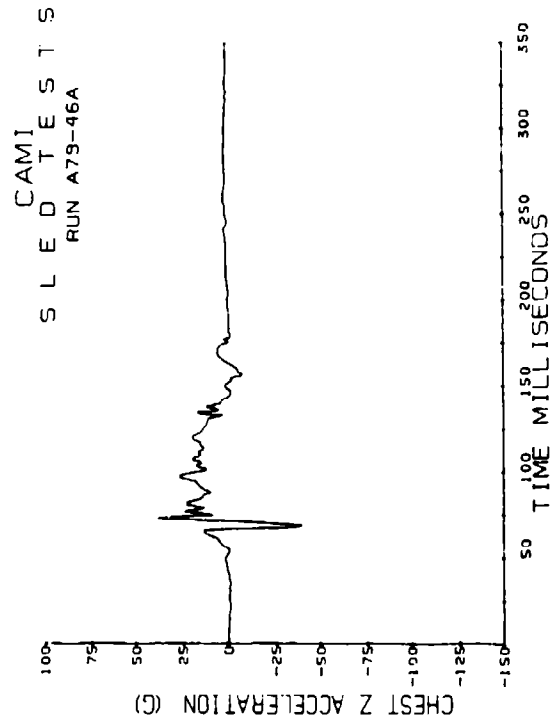
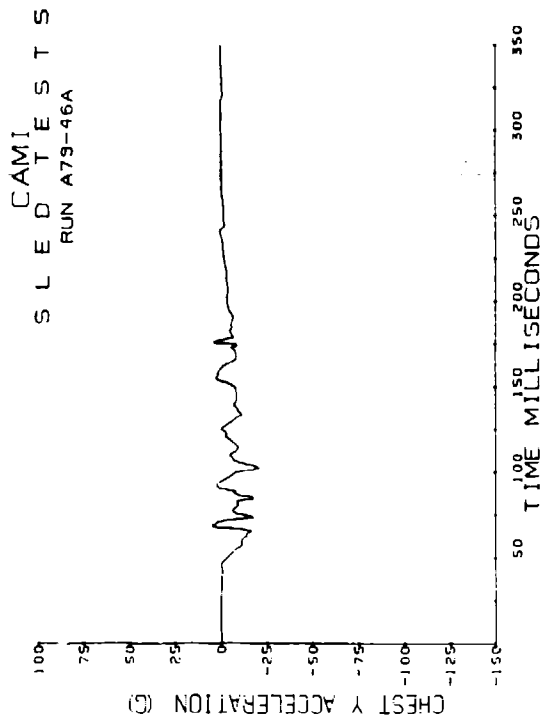
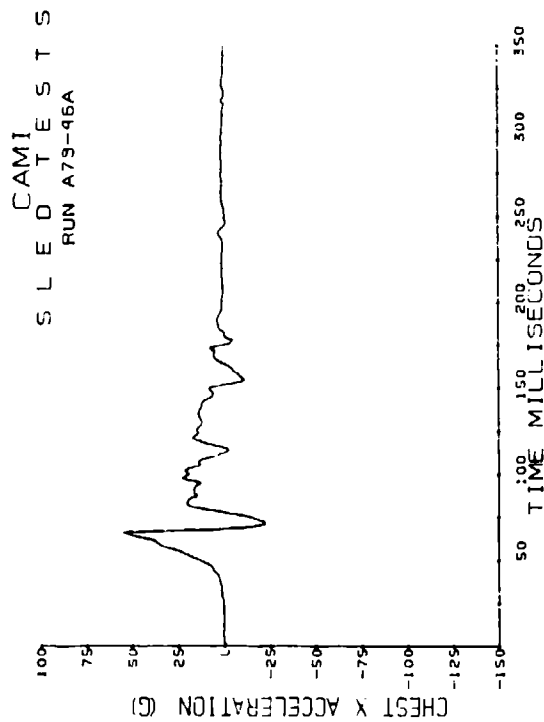
CAMI
S L E D T E S T S
R/JN A79-46A

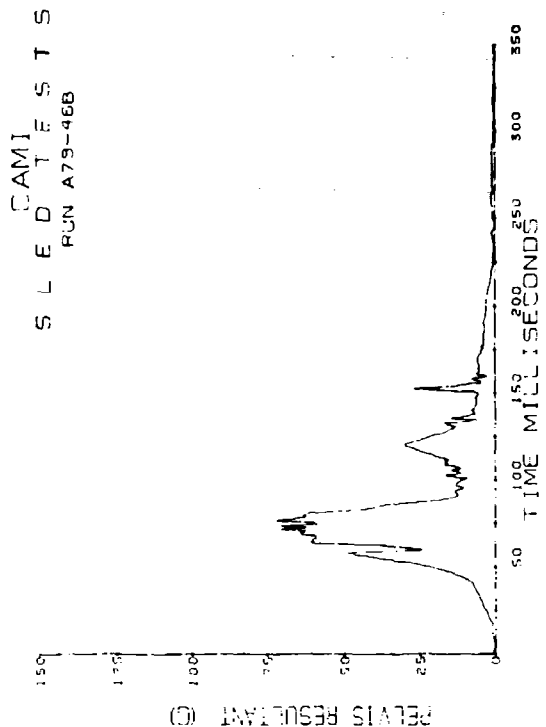
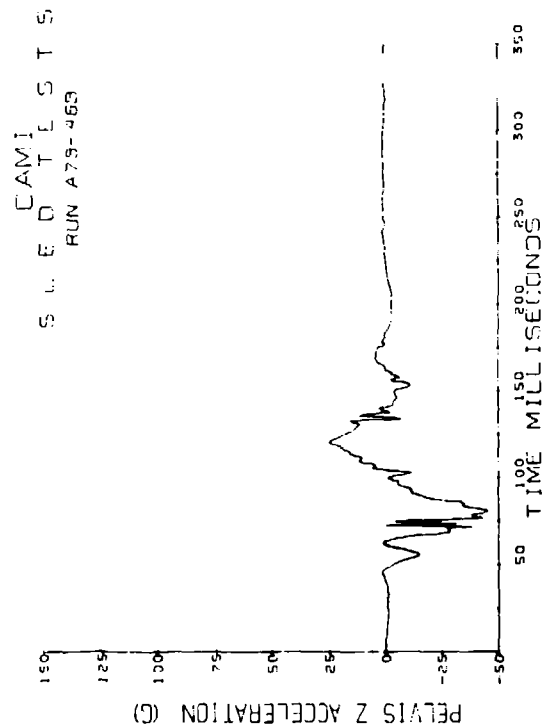
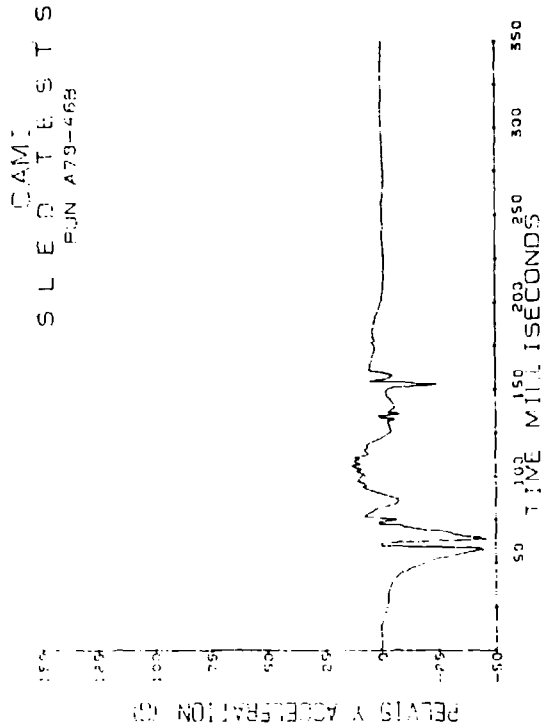
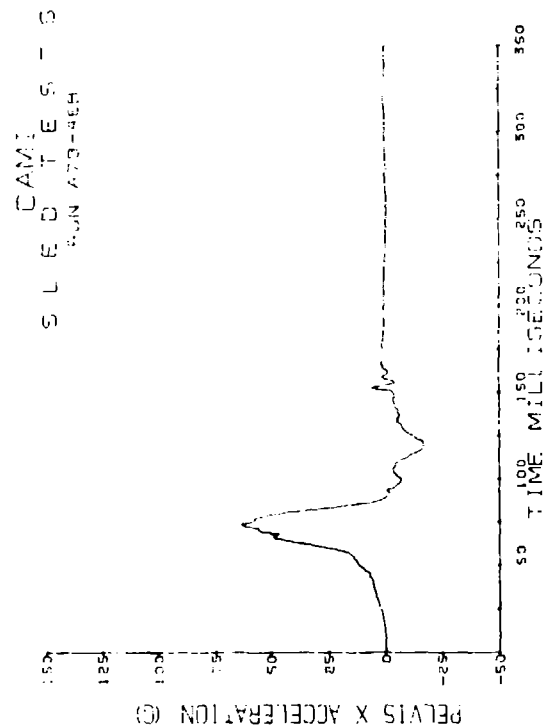


CAMI
S L E D T E S T S
R/JN A79-46A

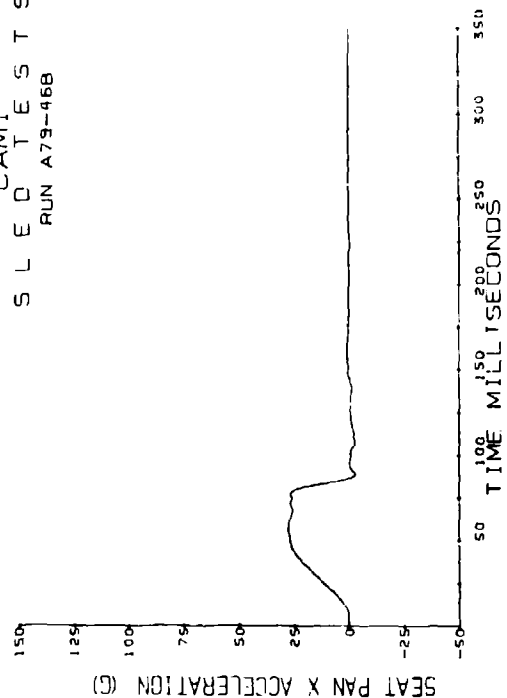




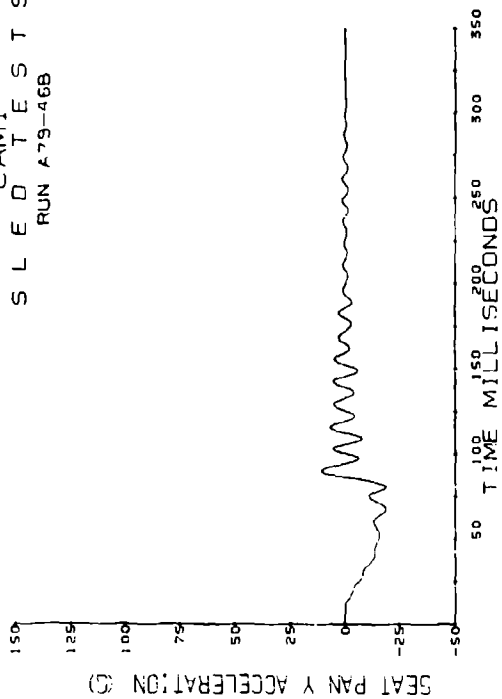




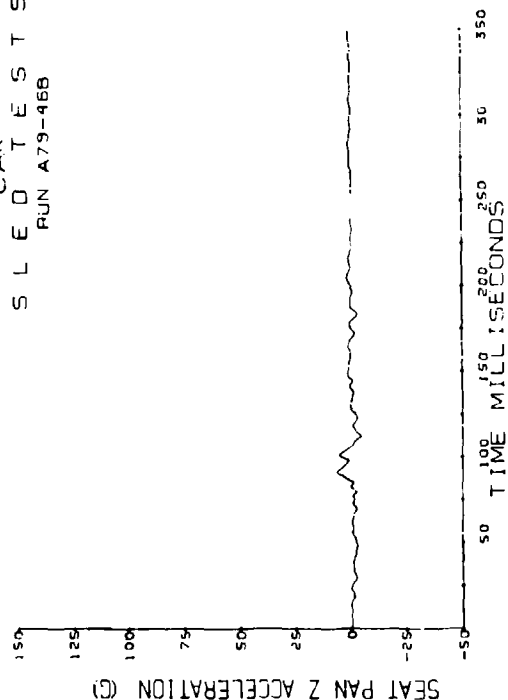
CAMI
S L E D T E S T S
RUN A79-468



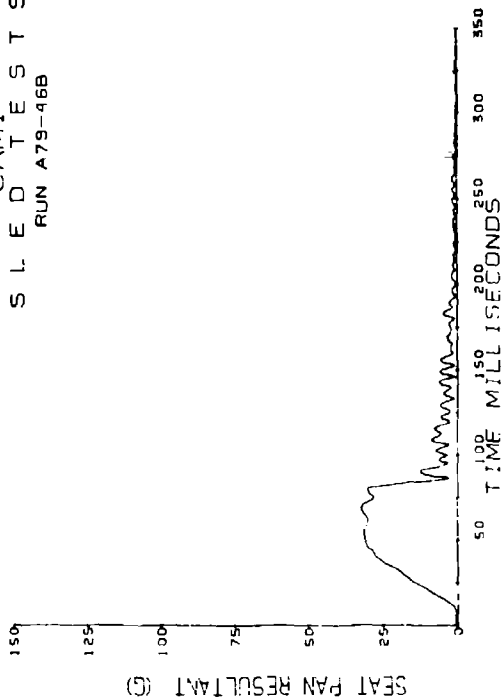
CAMI
S L E D T E S T S
RUN A79-468



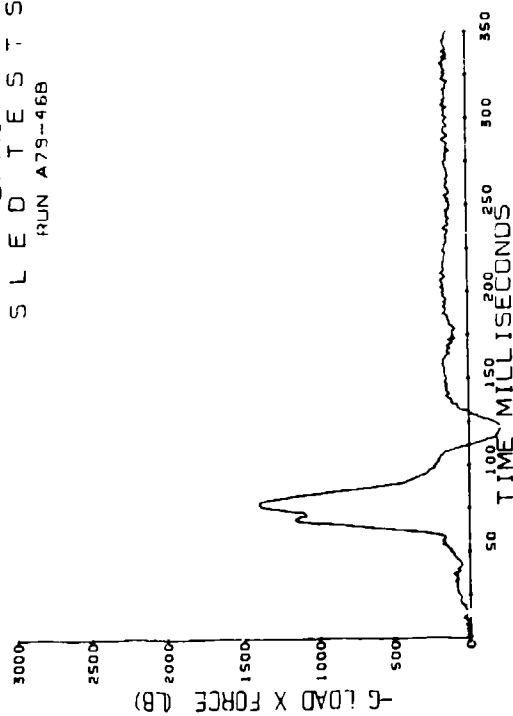
CAMI
S L E D T E S T S
RUN A79-468



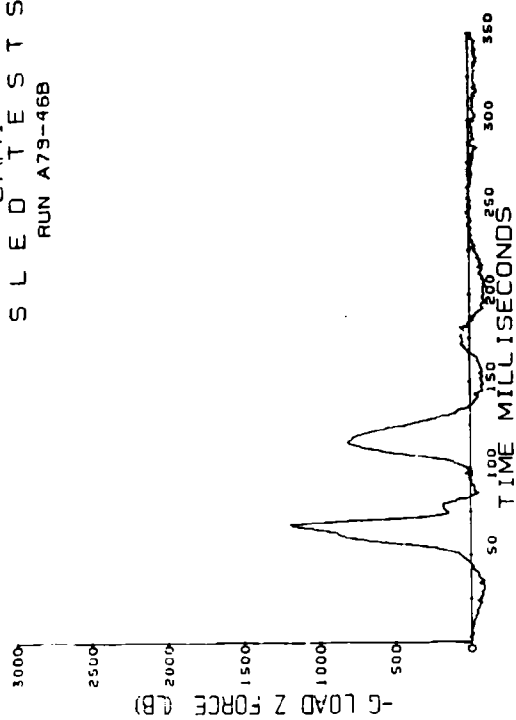
CAMI
S L E D T E S T S
RUN A79-468



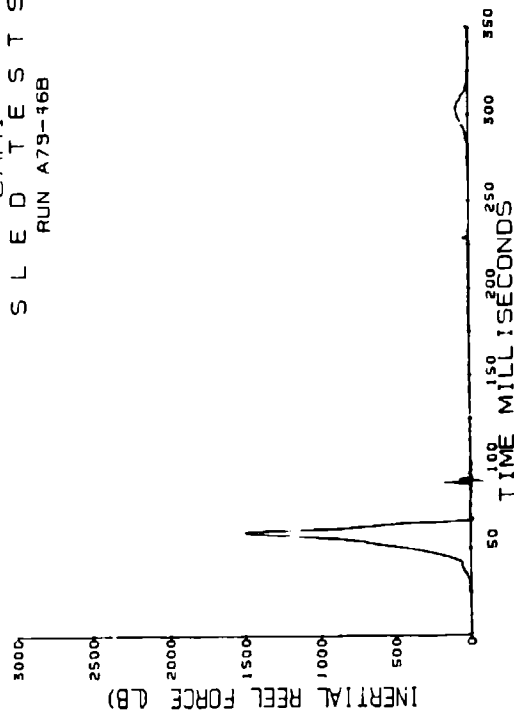
CAMI
S L E D T E S T S
RUN A79-46B



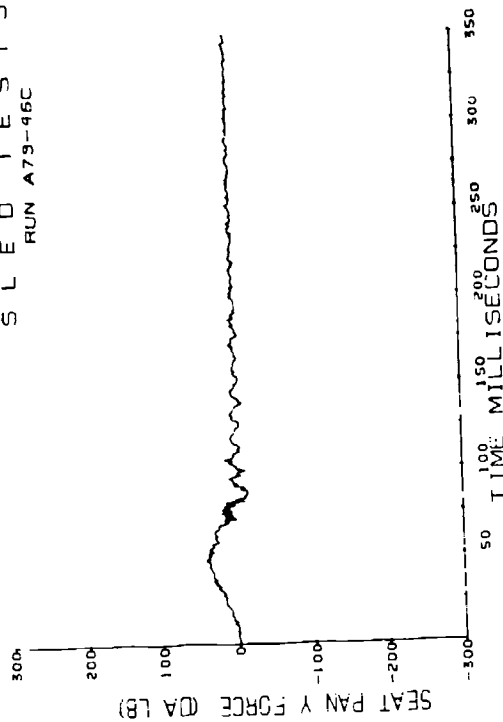
CAMI
S L E D T E S T S
RUN A79-46B



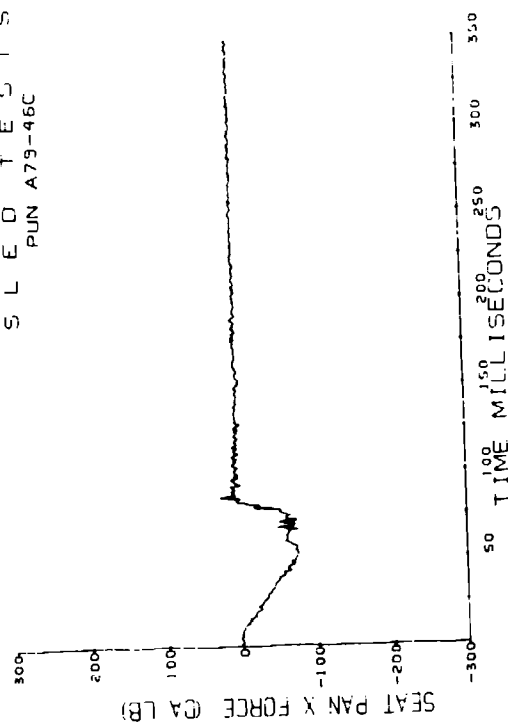
CAMI
S L E D T E S T S
RUN A79-46B



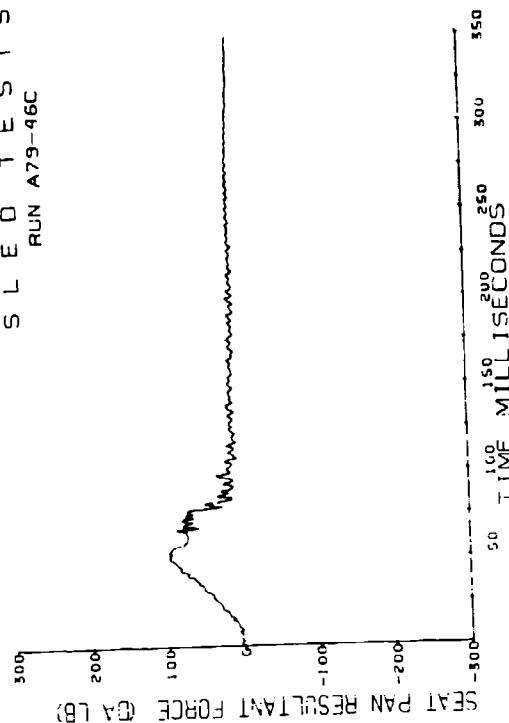
CAMI
S L E D T E S T S
RUN A79-46C



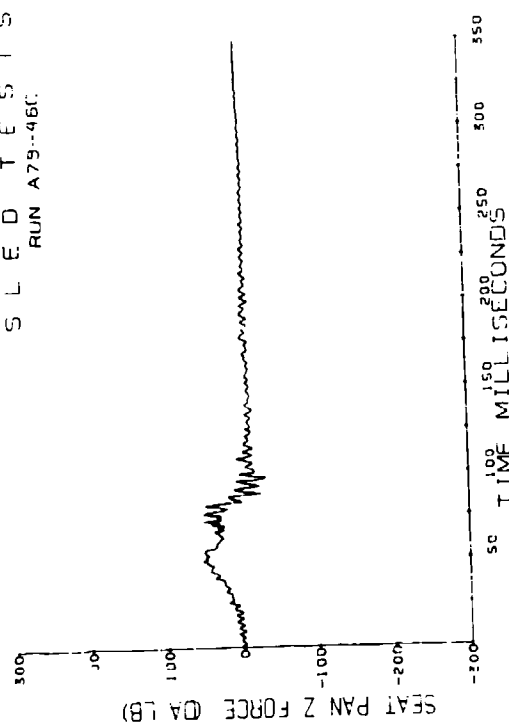
CAMI
S L E D T E S T S
RUN A79-46C



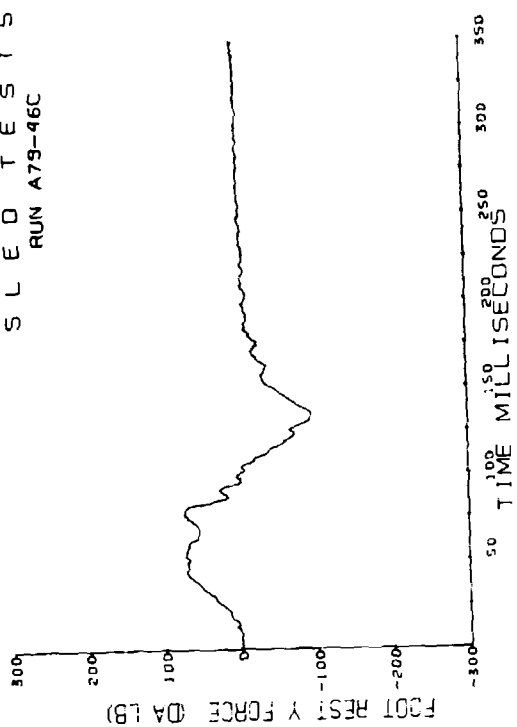
CAMI
S L E D T E S T S
RUN A79-46C



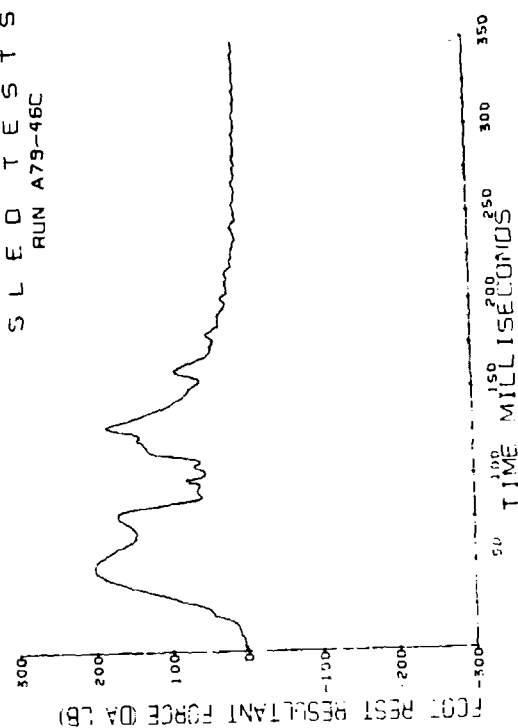
CAMI
S L E D T E S T S
RUN A79-46C



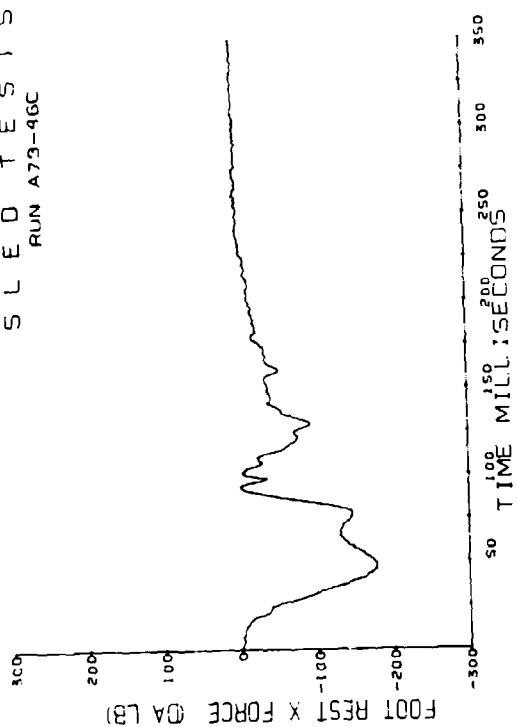
CAMI
S L E D T E S T S
RUN A79-46C



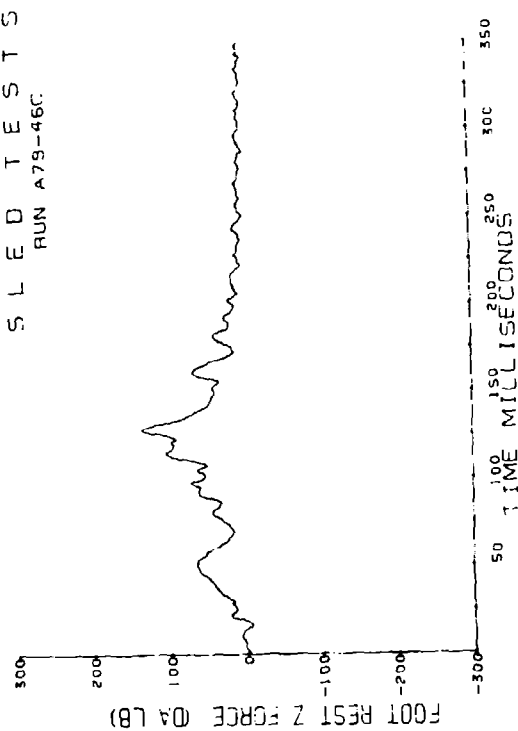
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S L E D T E S T S
RUN A79-46C



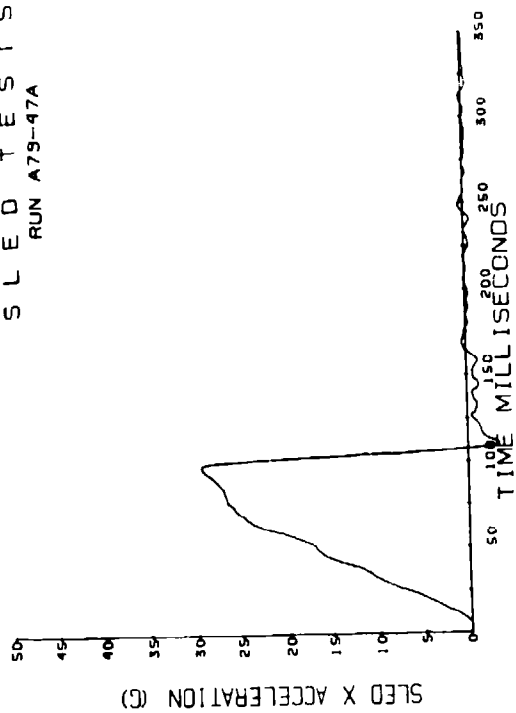
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S L E D T E S T S
RUN A79-46C



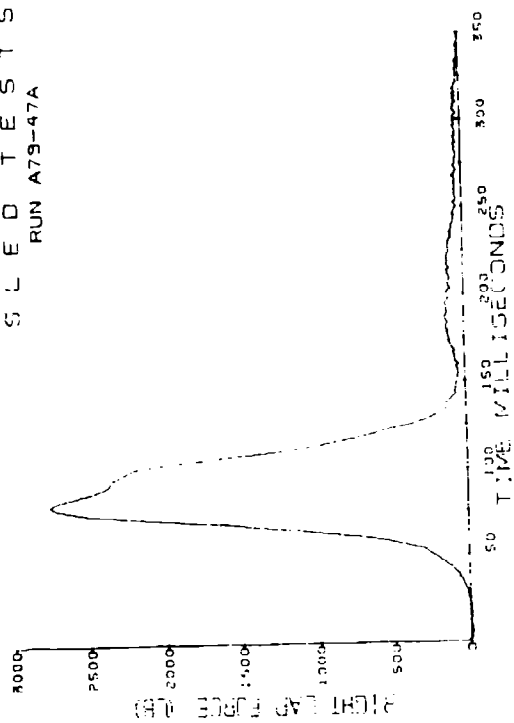
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S L E D T E S T S
RUN A79-46C



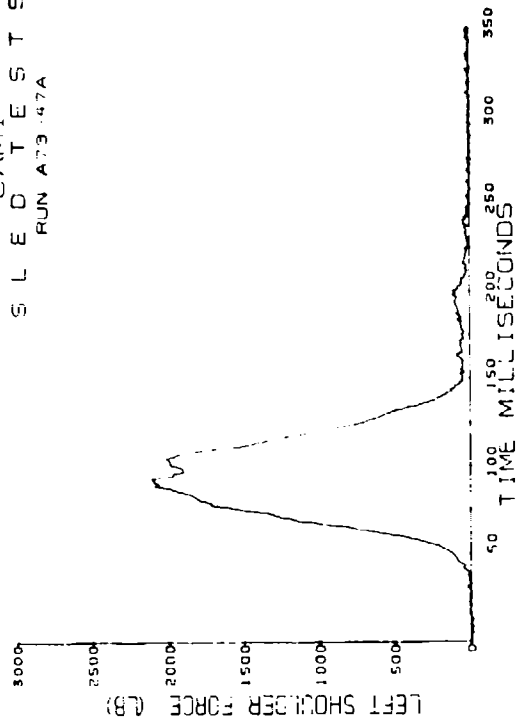
CAMI
S L E D T E S T S
RUN A79-47A



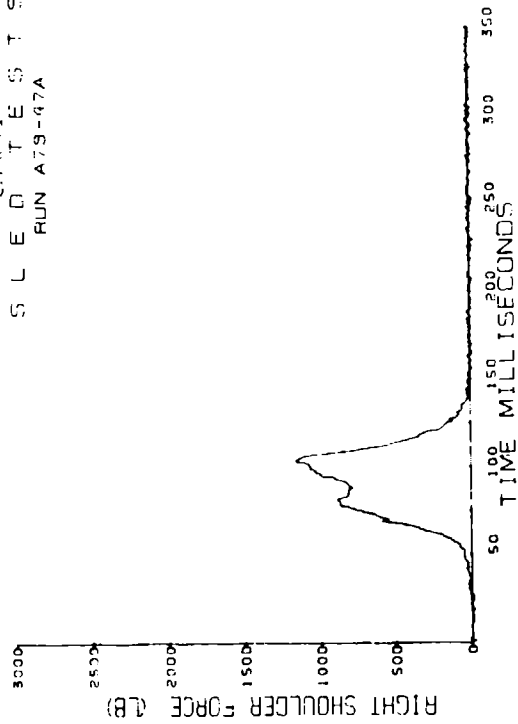
CAMI
S L E D T E S T S
RUN A79-47A



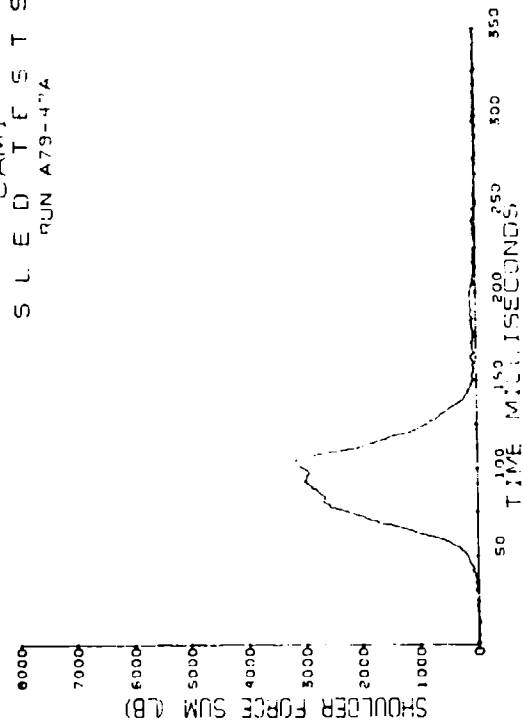
CAMI
S L E D T E S T S
RUN A79-47A

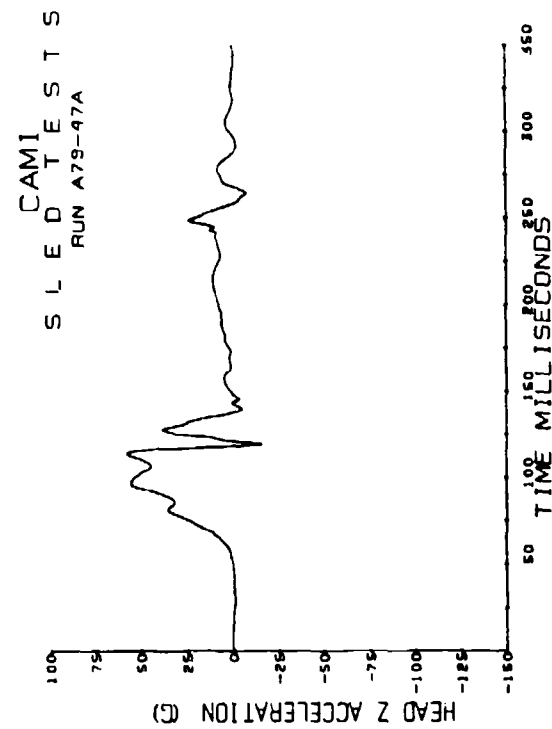
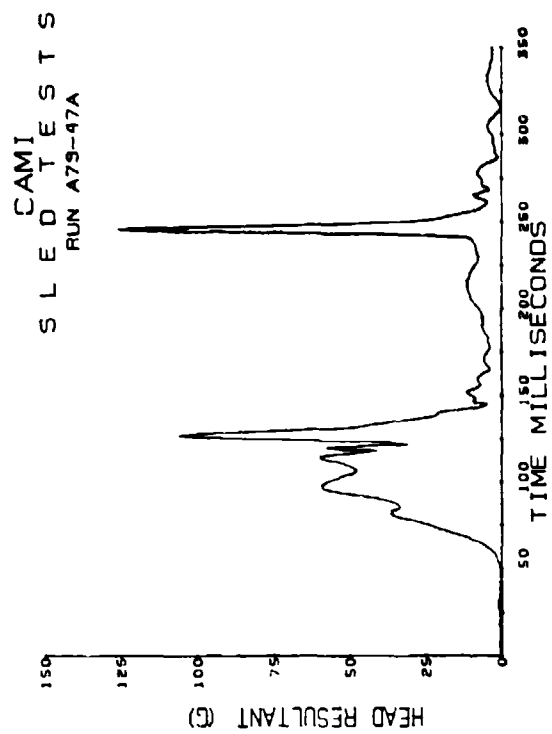
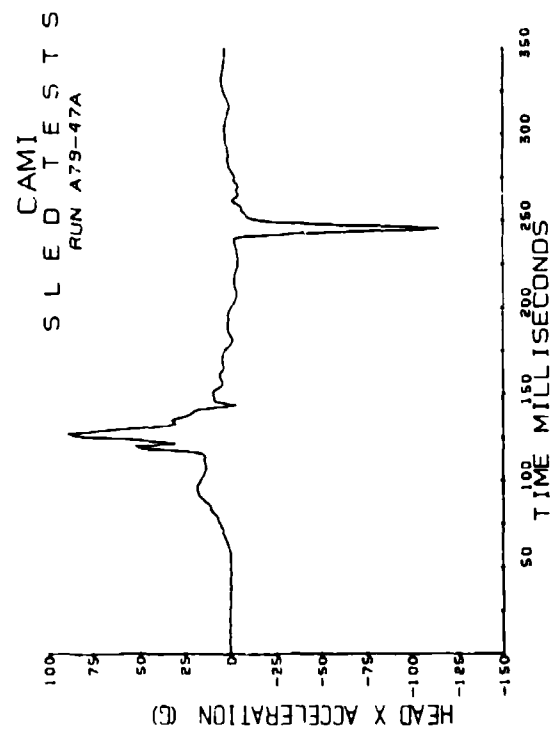
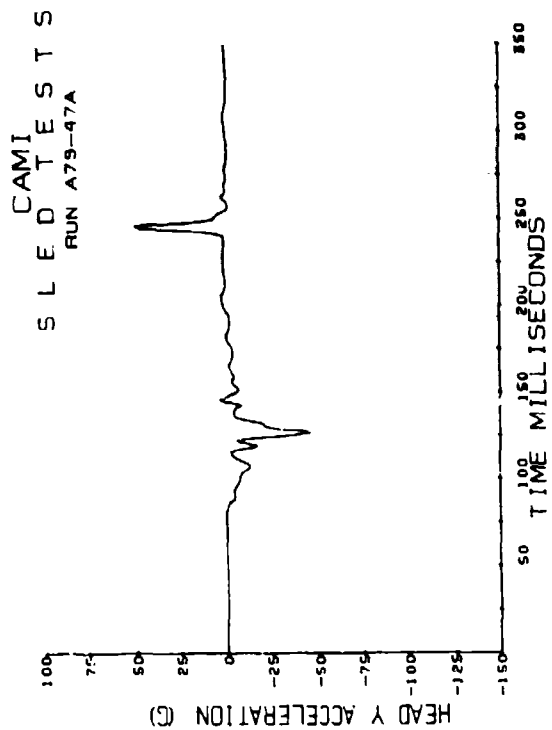


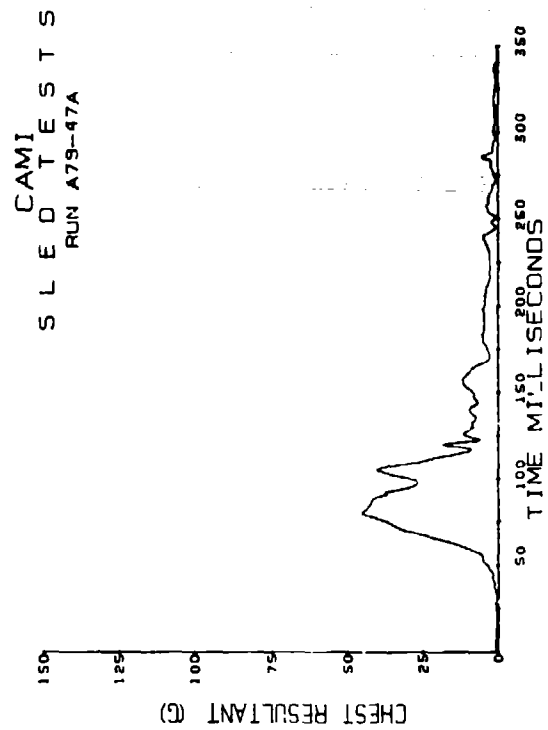
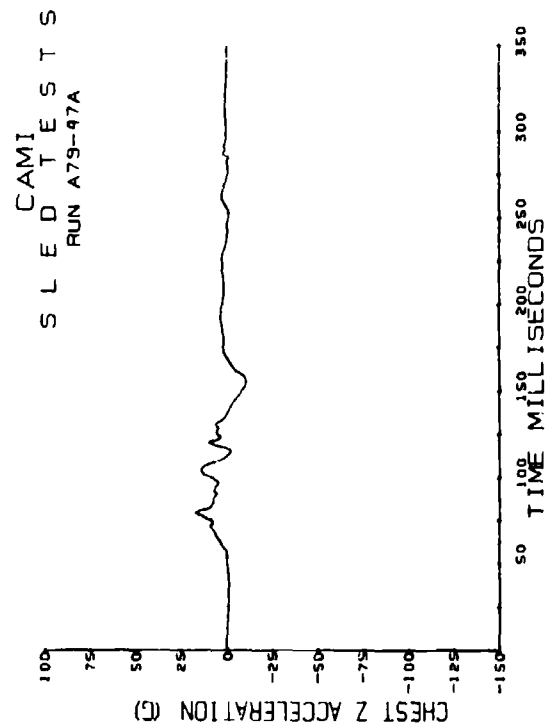
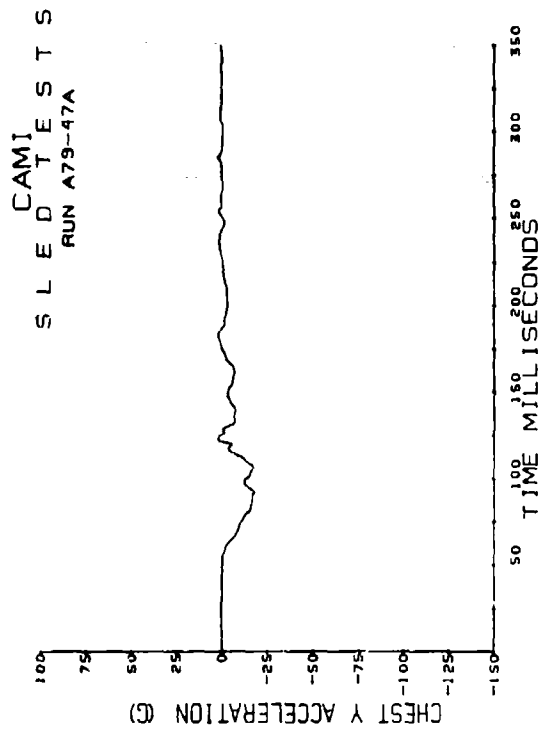
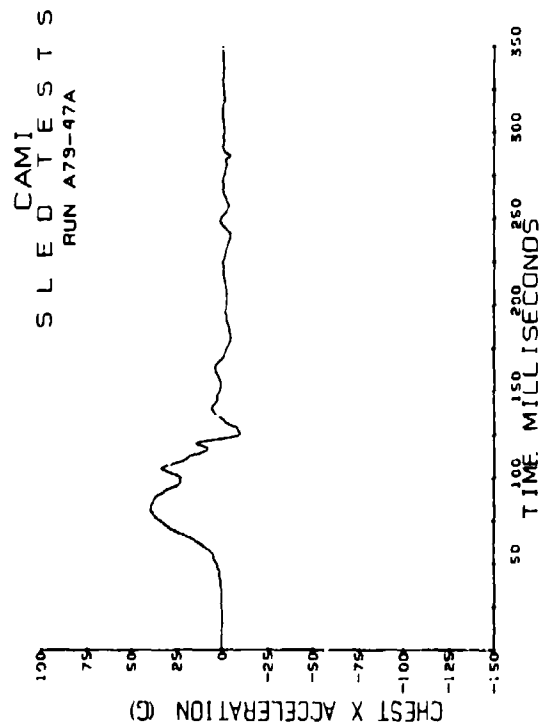
CAMI
S L E D T E S T S
RUN A79-47A

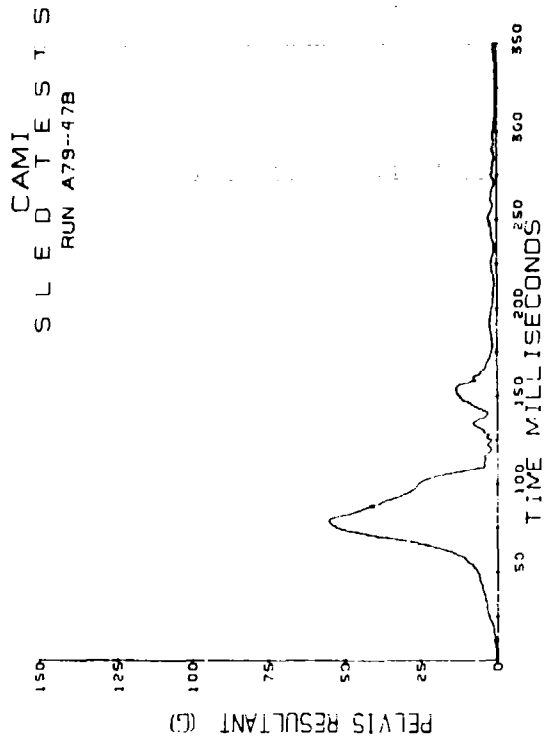
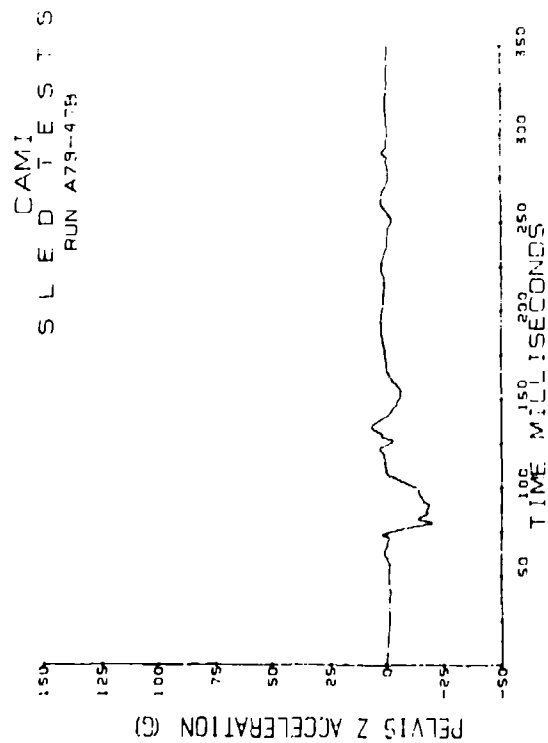
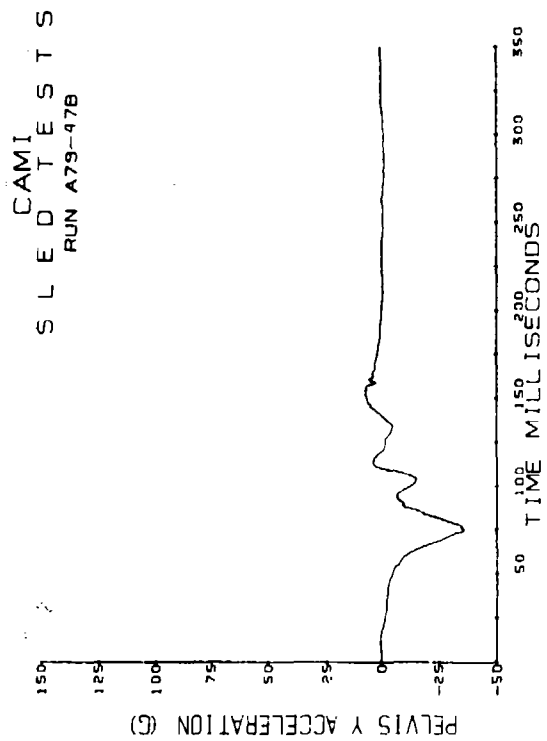
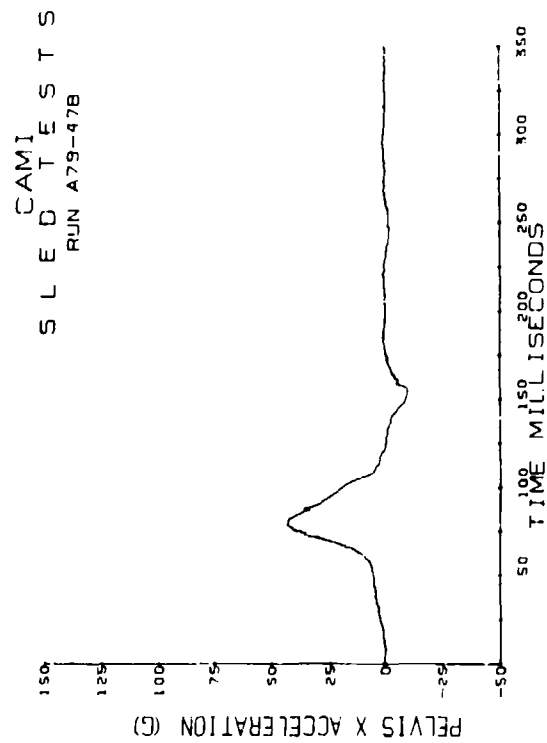


CAMI
S L E D T E S T S
RUN A79-47A

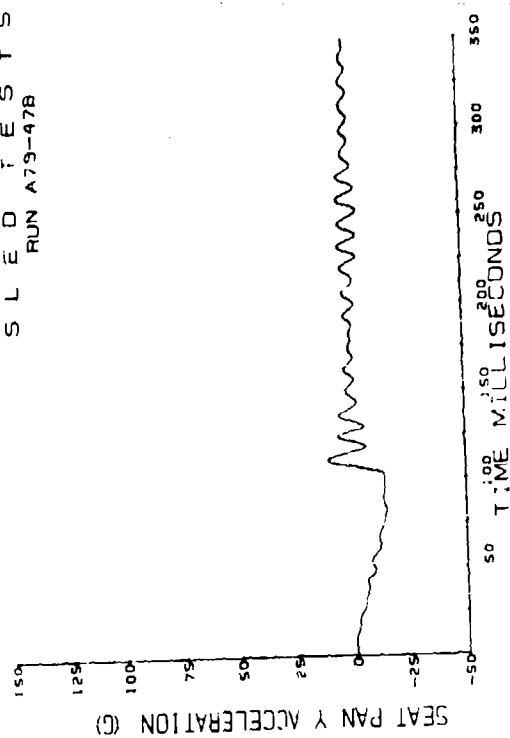




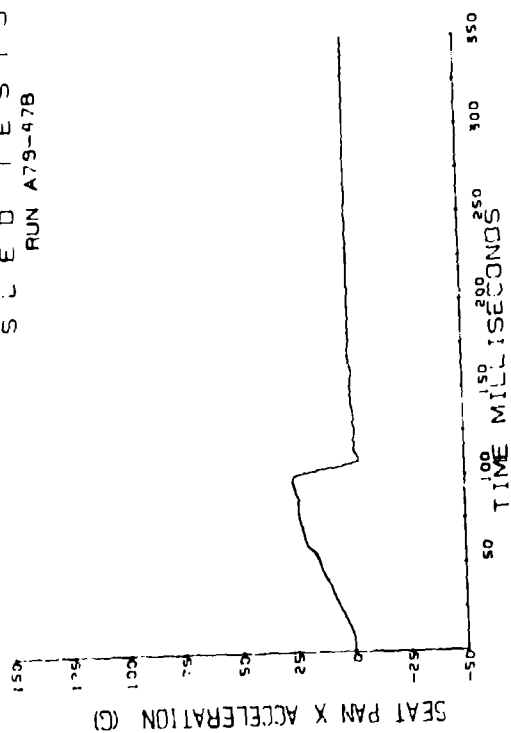




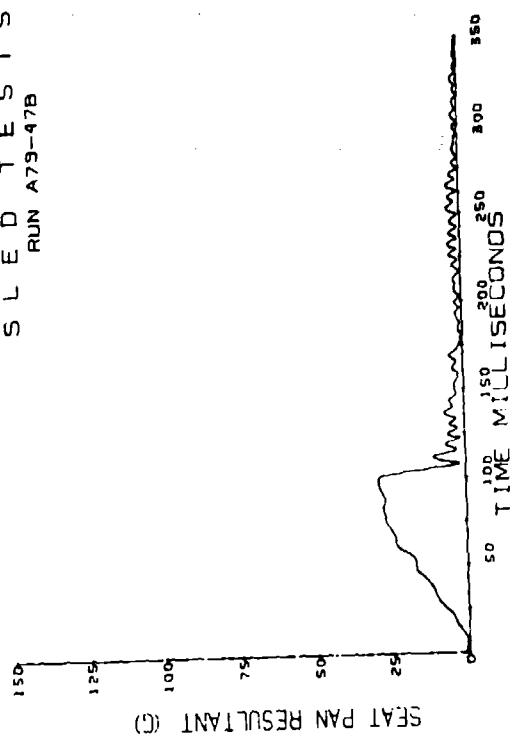
CAMI
S L E D T E S T S
RUN A79-47B



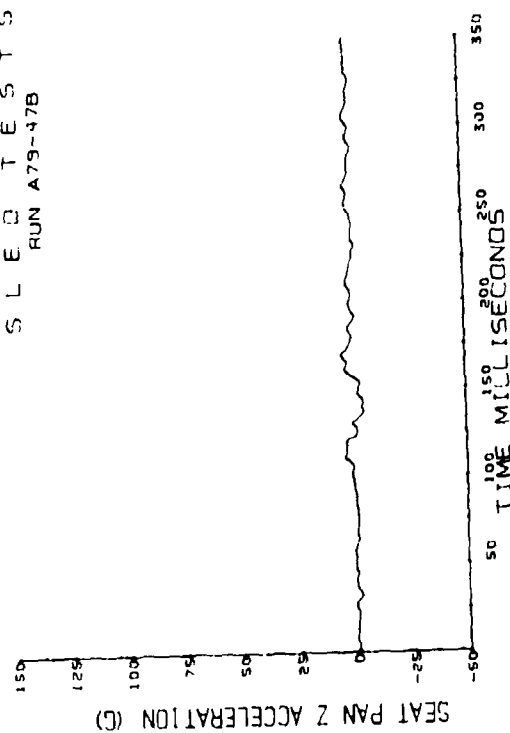
CAMI
S L E D T E S T S
RUN A79-47B



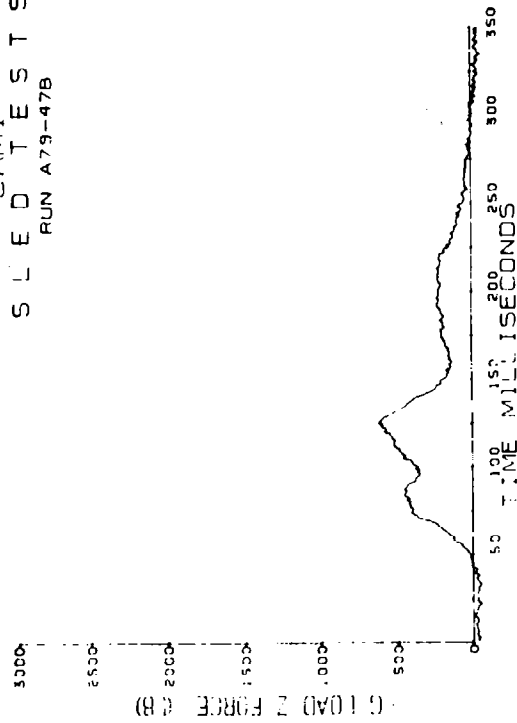
CAMI
S L E D T E S T S
RUN A79-47B



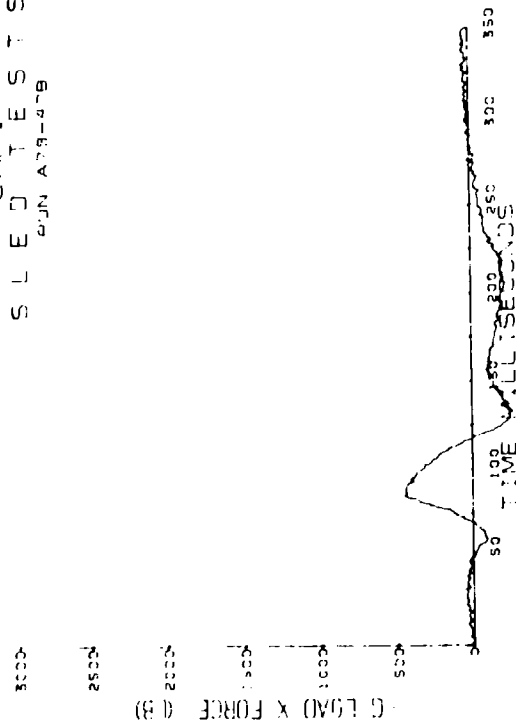
CAMI
S L E D T E S T S
RUN A79-47B



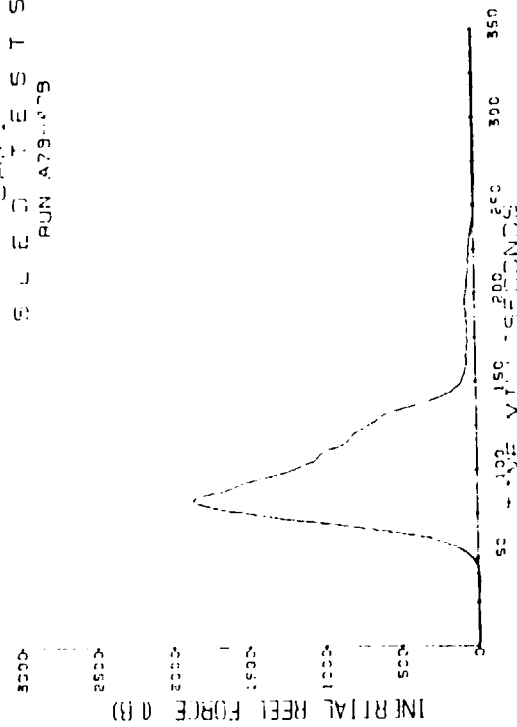
CAMI S L E D T E S T S RUN A79-47B

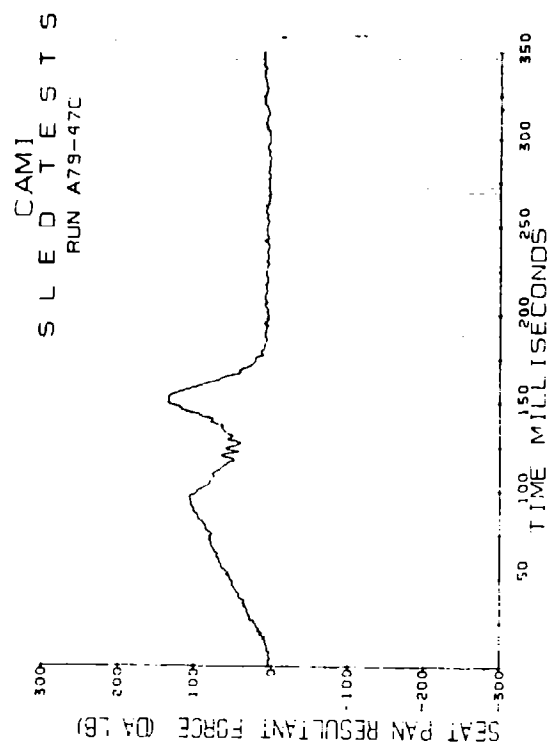
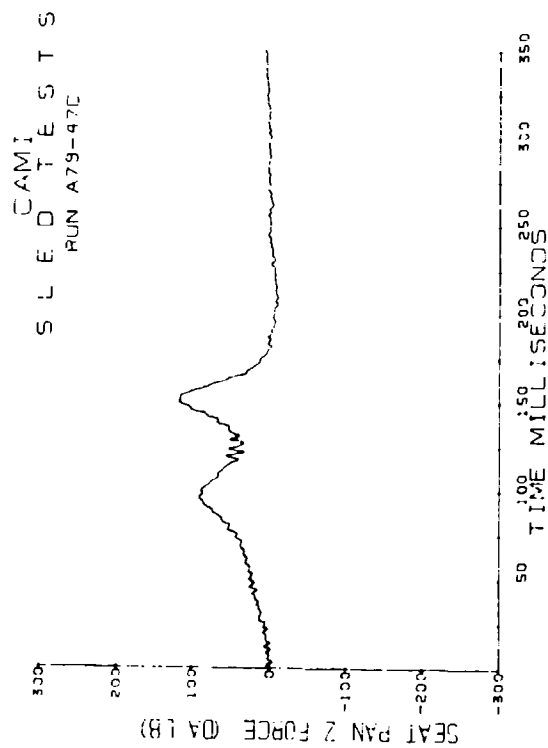
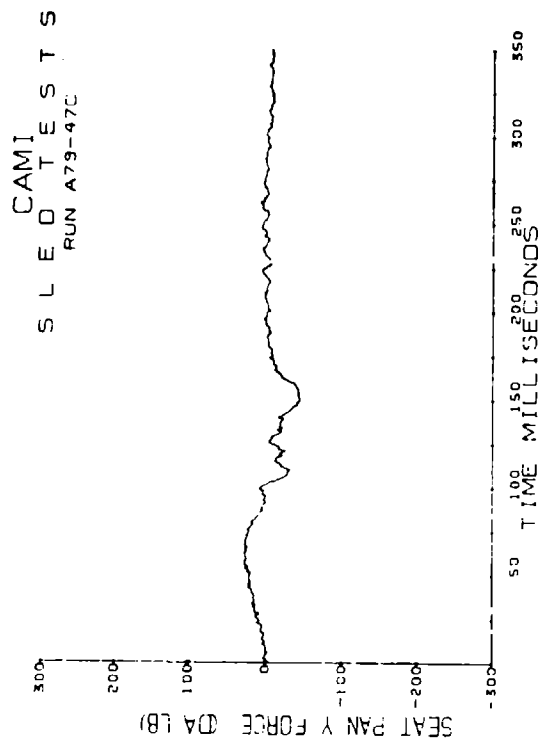
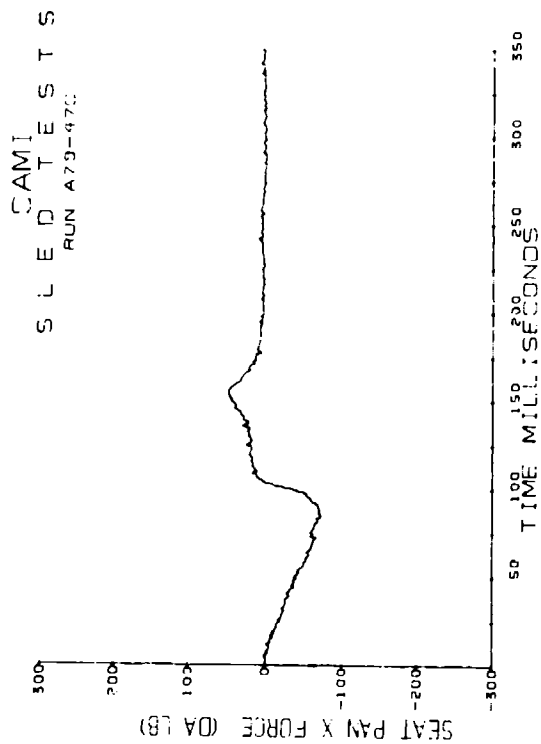


CAMI S L E D T E S T S RUN A79-47B

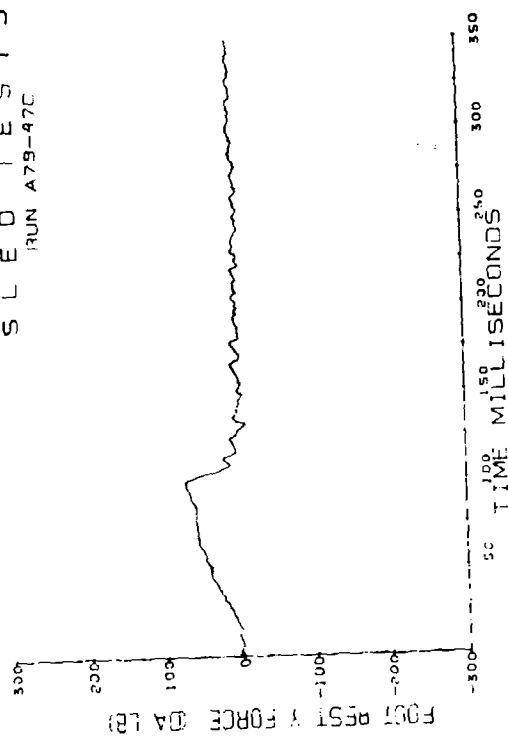


CAMI S L E D T E S T S RUN A79-47B

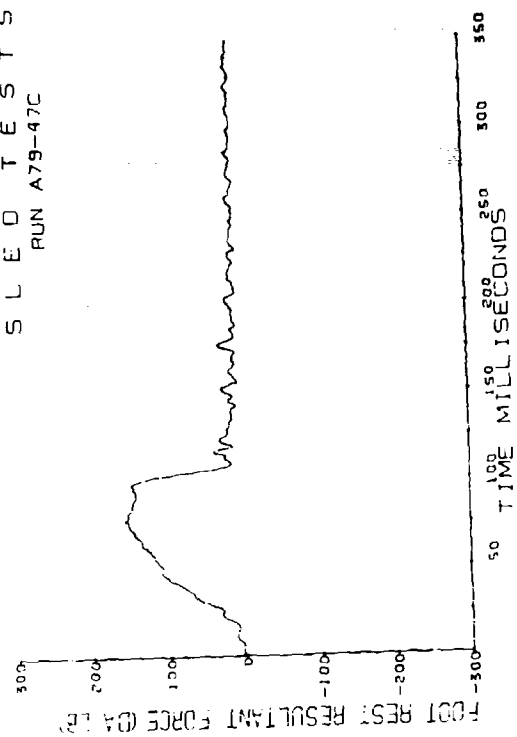




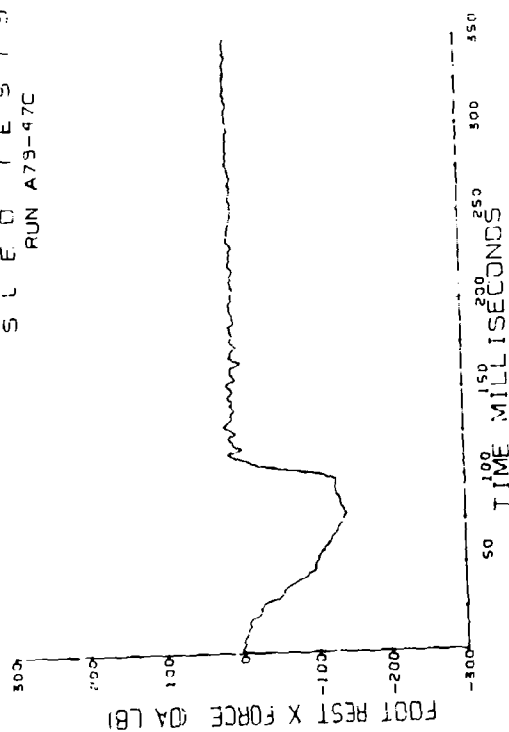
CAMI
S L E D T E S T S
RUN A79-47C



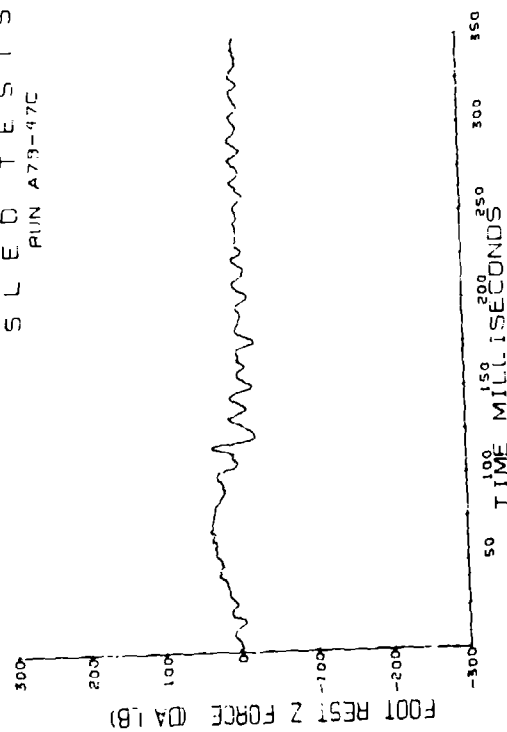
CAMI
S L E D T E S T S
RUN A79-47C

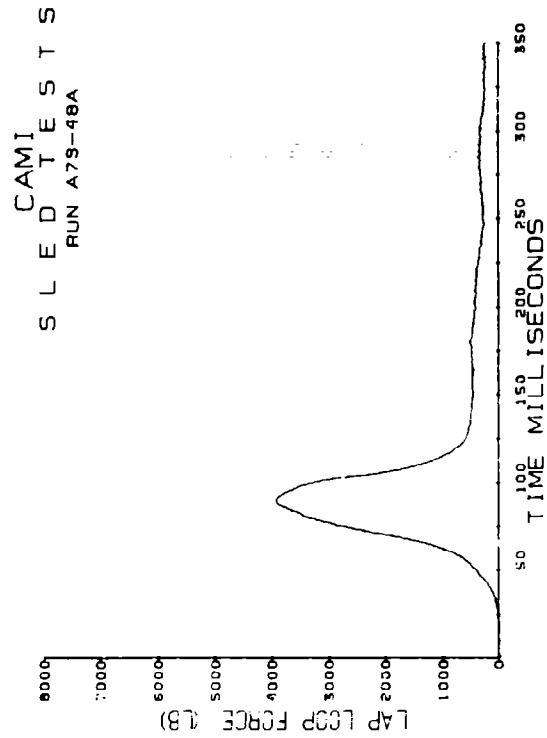
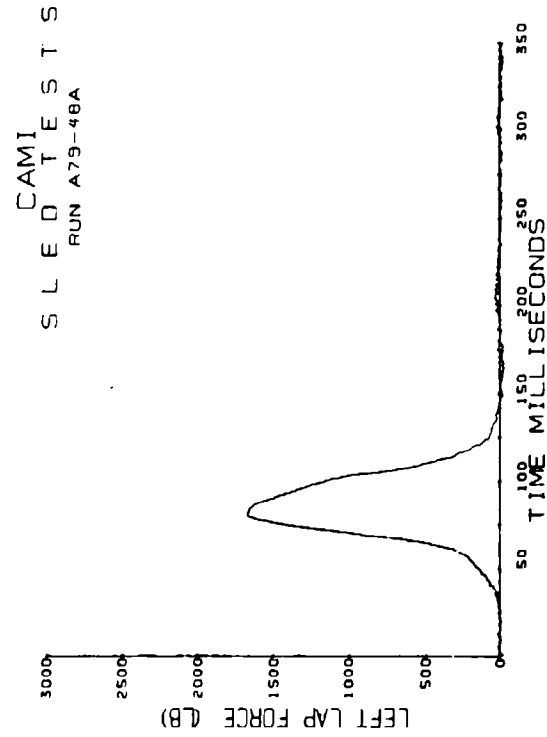
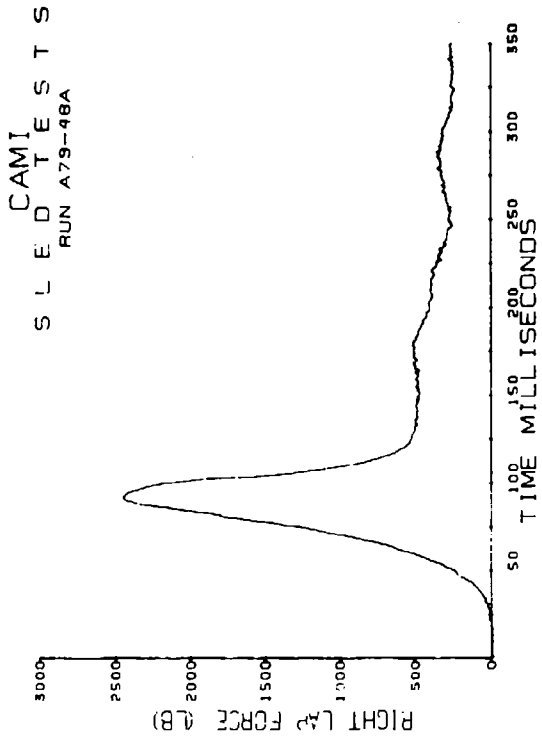
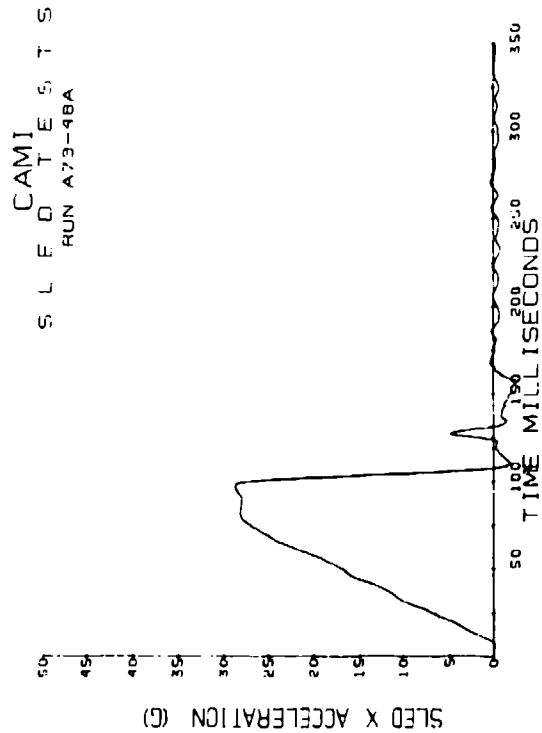


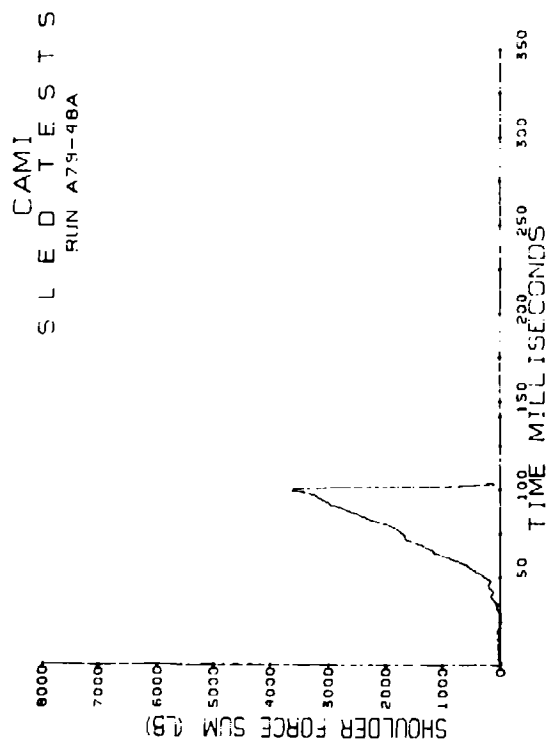
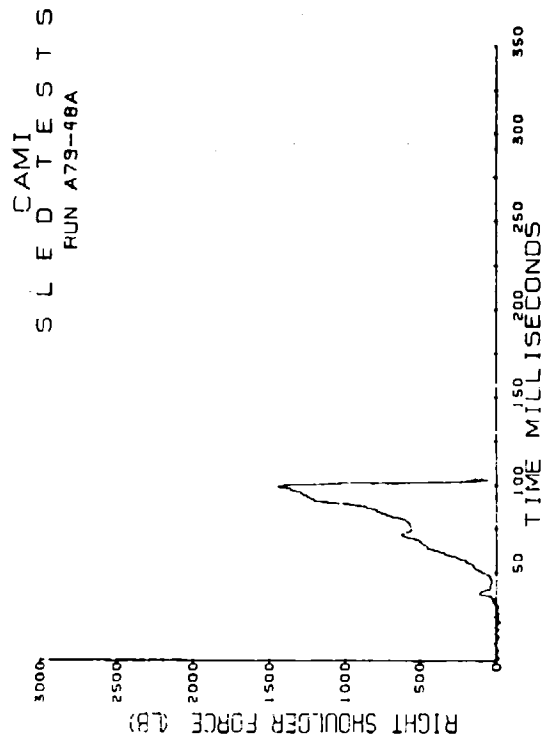
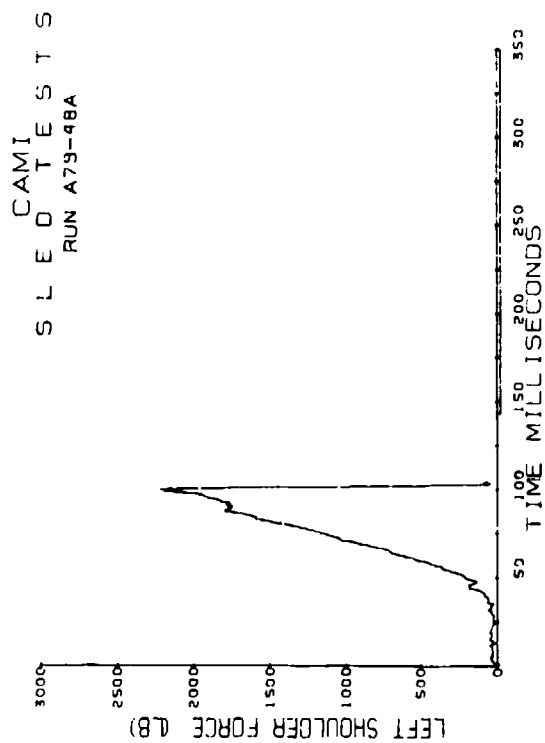
CAMI
S L E D T E S T S
RUN A79-47C

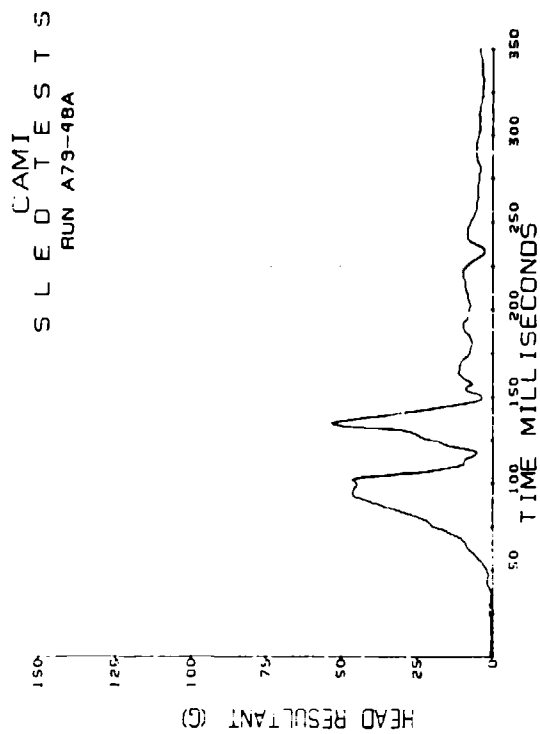
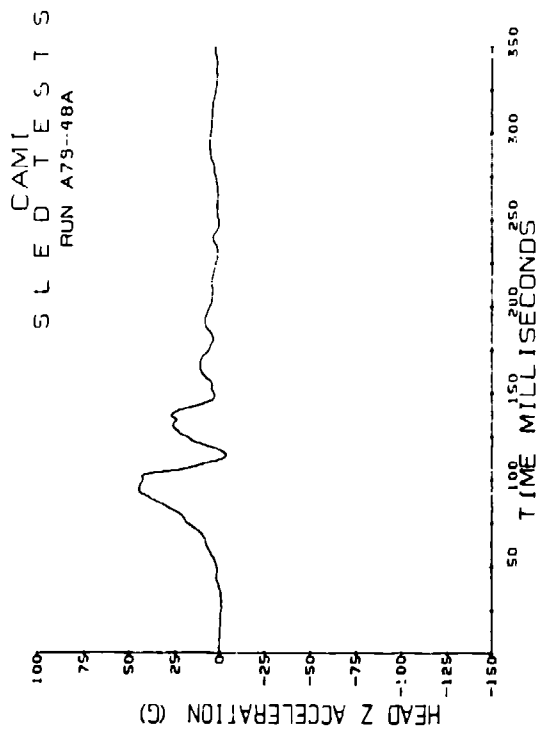
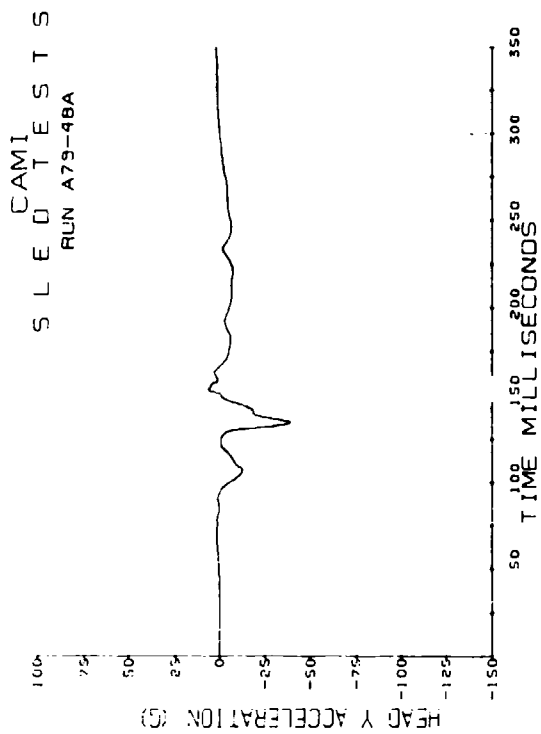
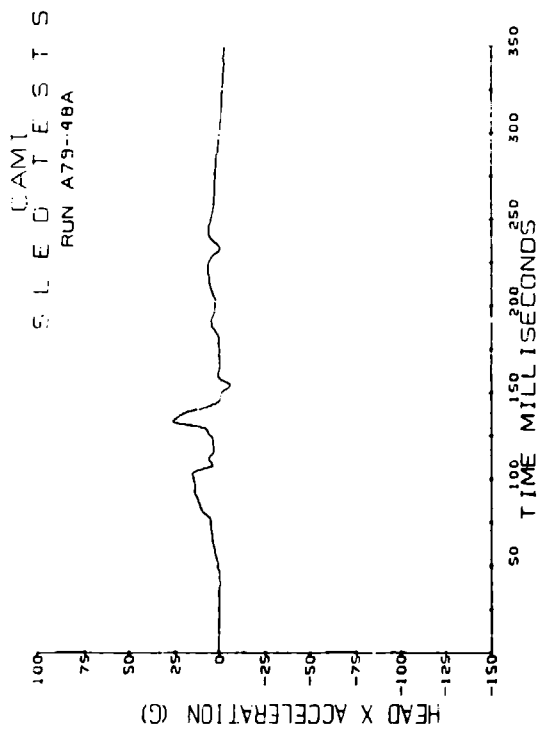


CAMI
S L E D T E S T S
RUN A79-47C

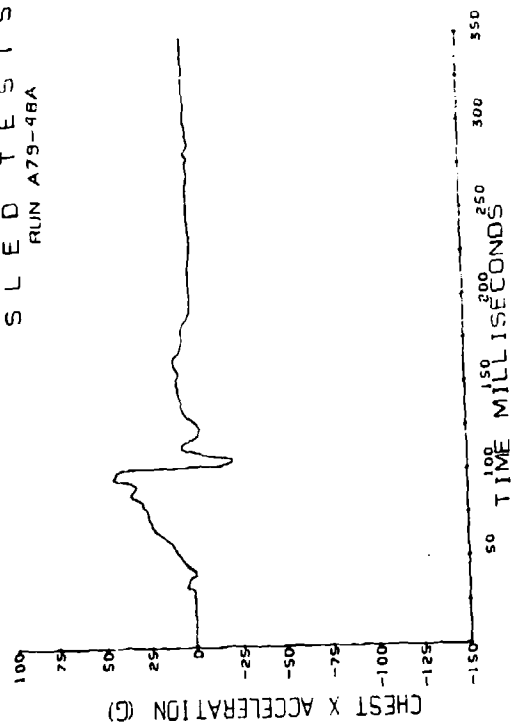




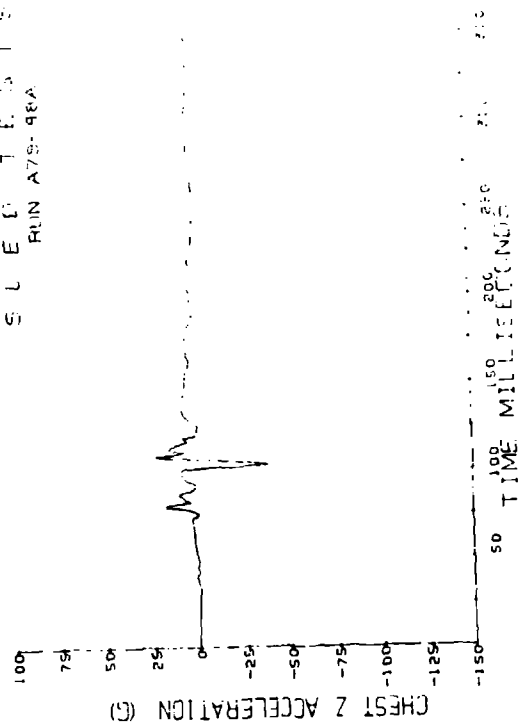




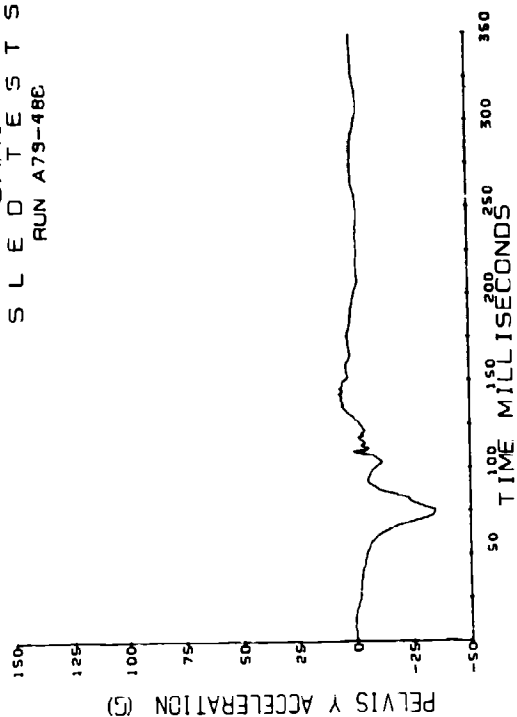
CAMI
S L E D T E S T S
RUN A79-98A



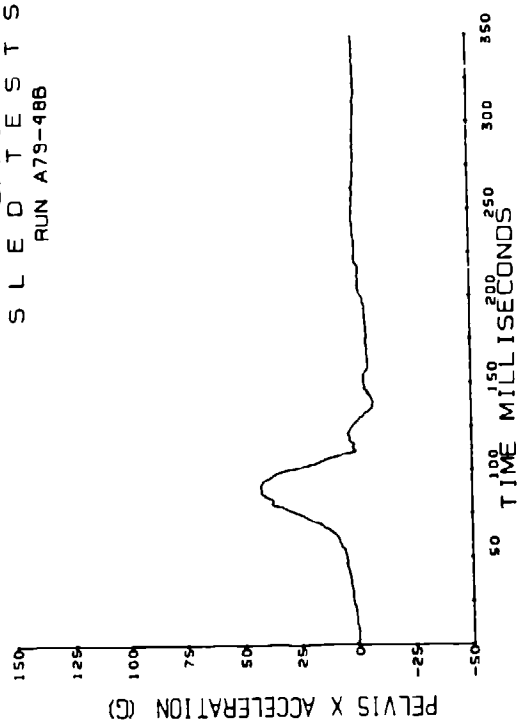
CAMI
S L E D T E S T S
RUN A79-98A



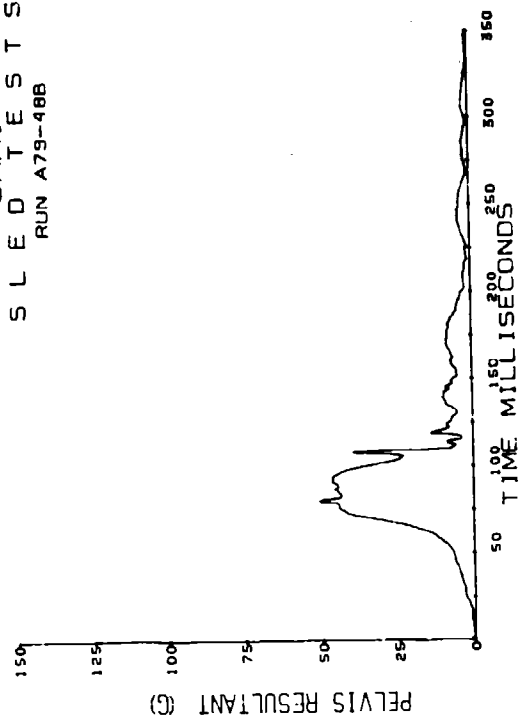
CAMI
S L E D T E S T S
RUN A79-486



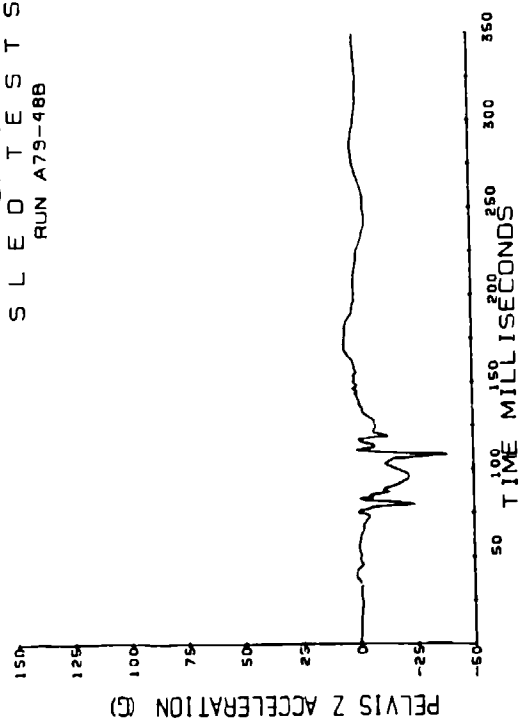
CAMI
S L E D T E S T S
RUN A79-488

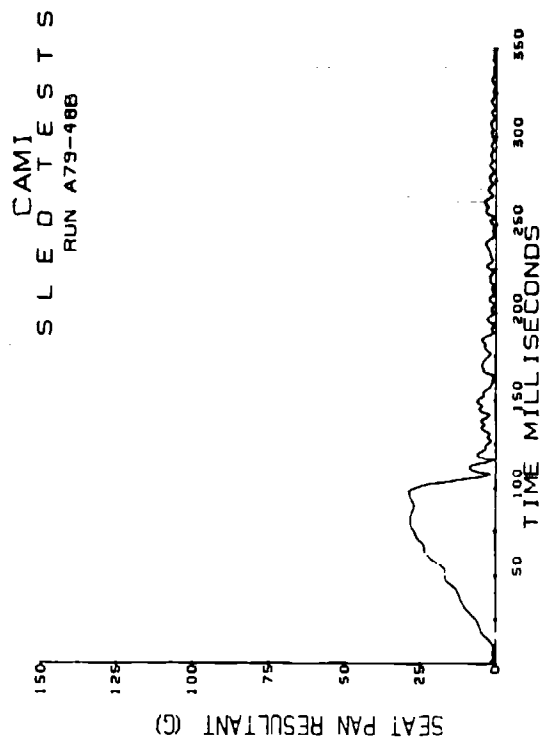
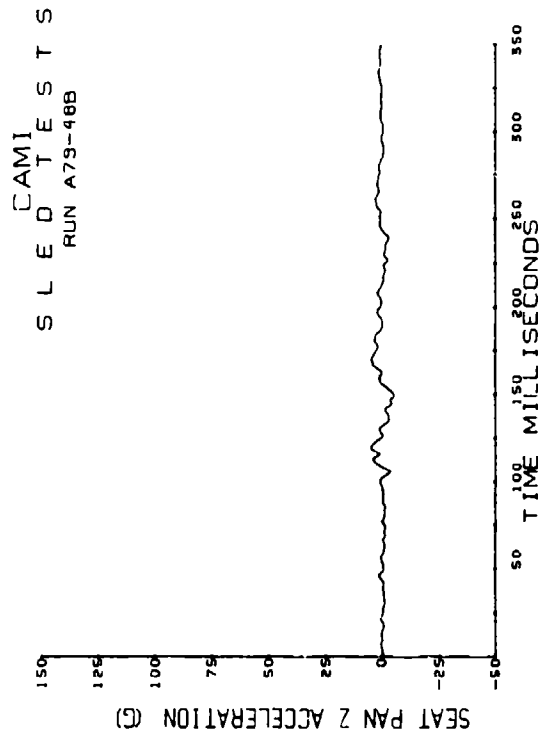
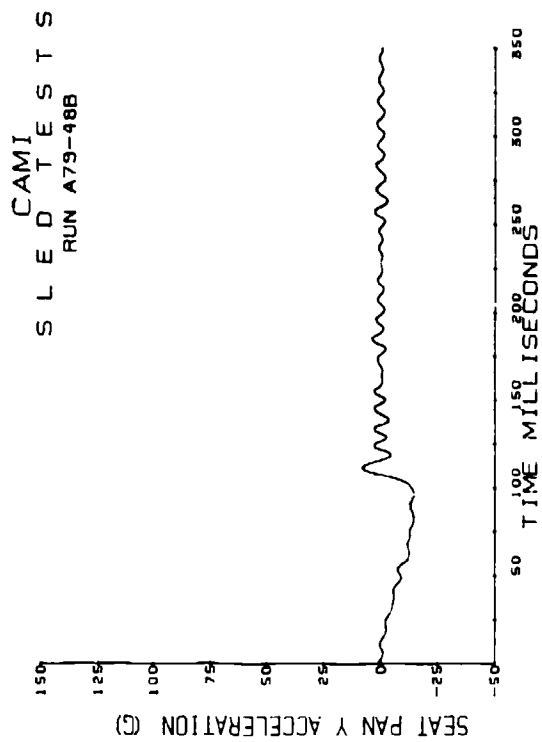
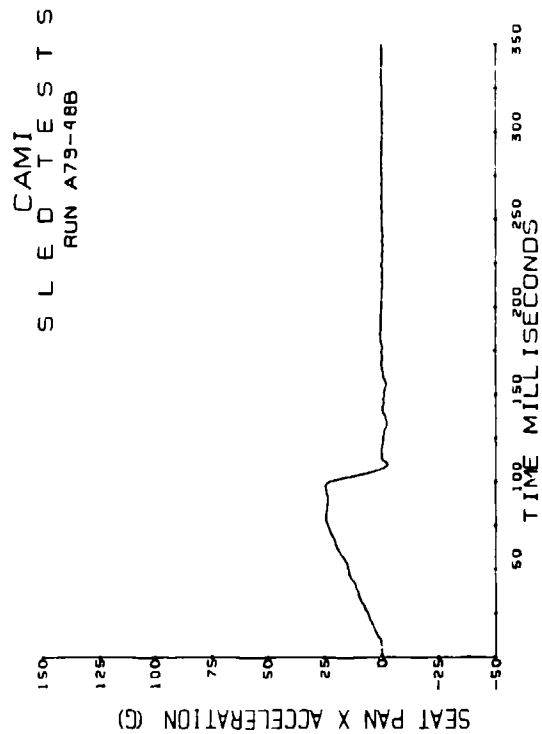


CAMI
S L E D T E S T S
RUN A79-488

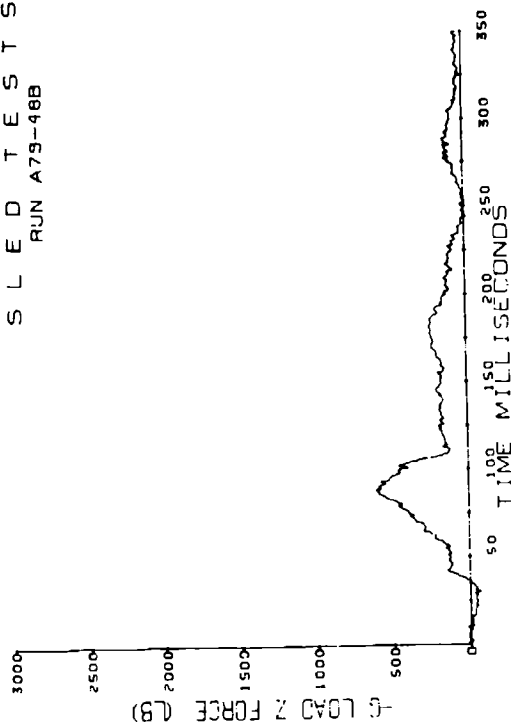


CAMI
S L E D T E S T S
RUN A79-488

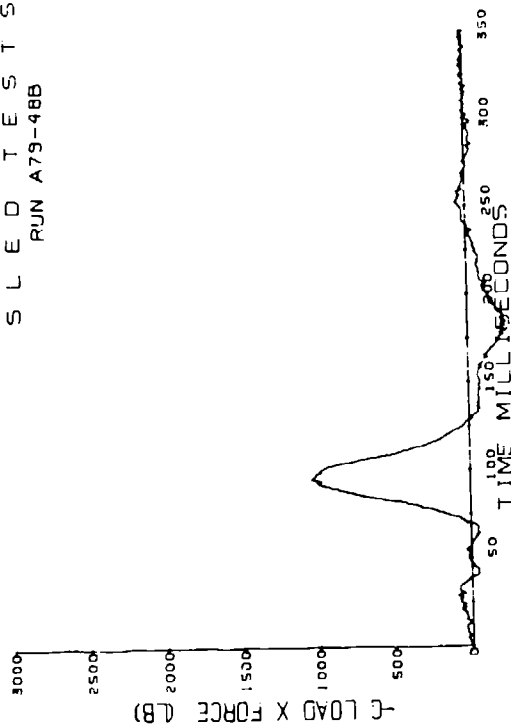




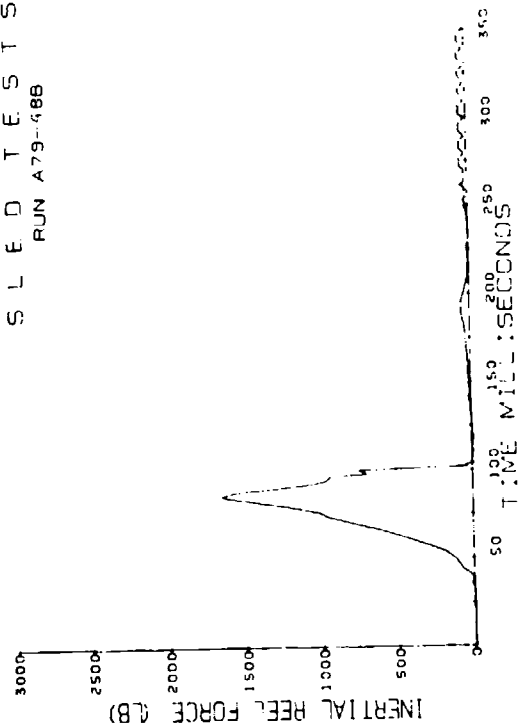
CAMI
S L E D T E S T S
RUN A79-48B

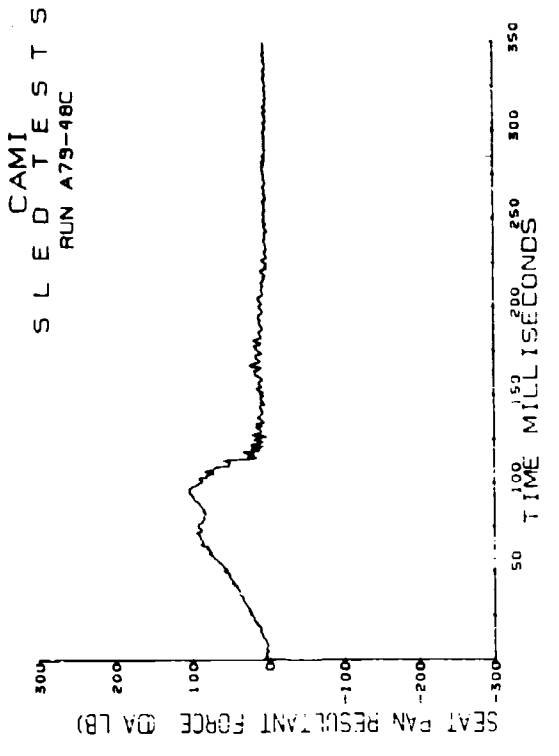
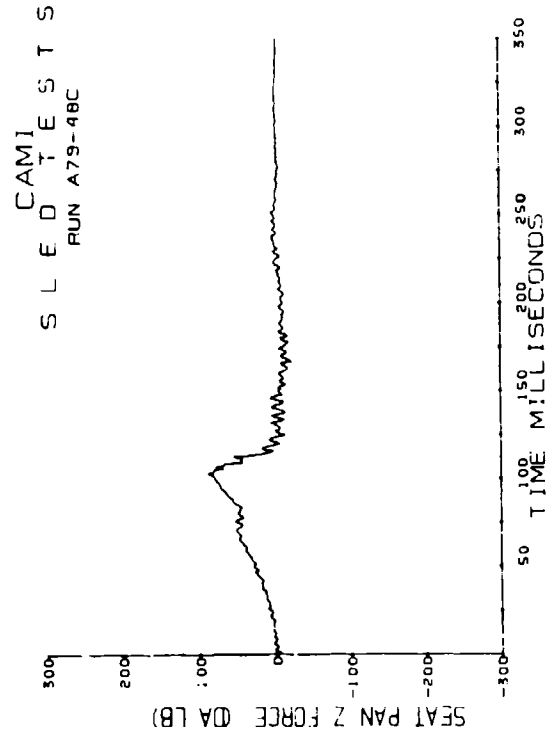
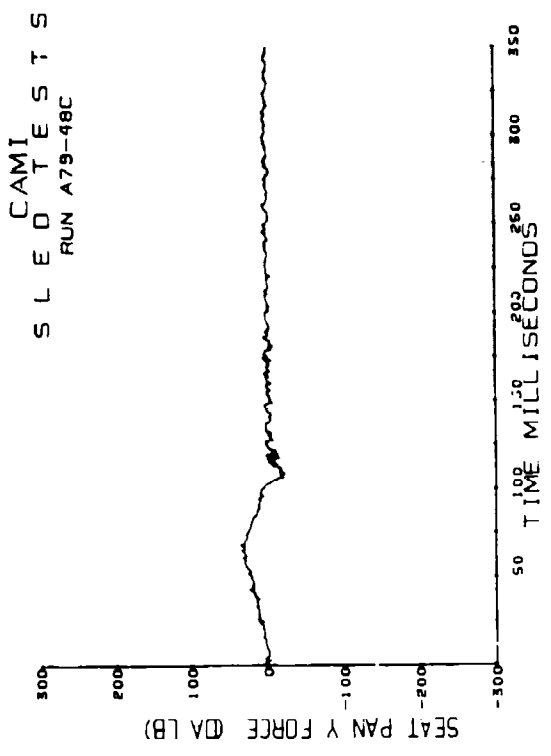
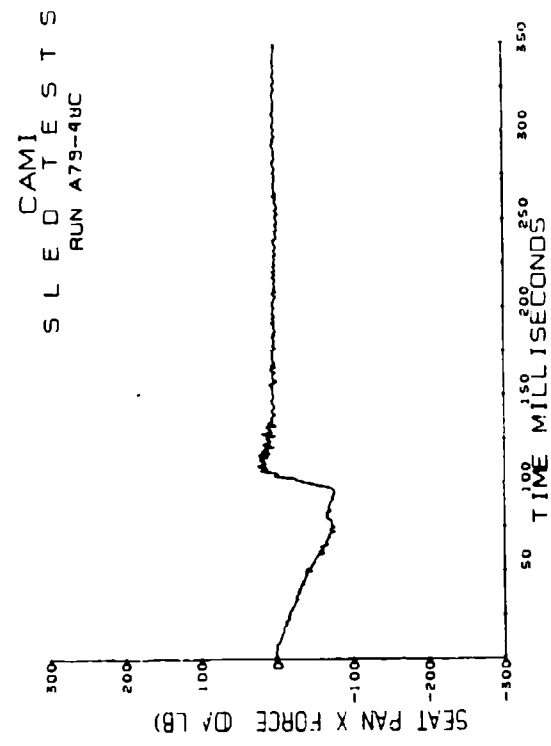


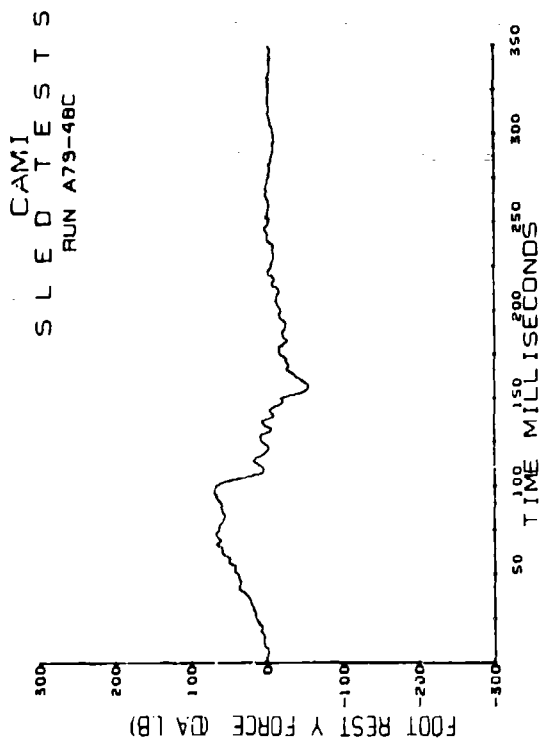
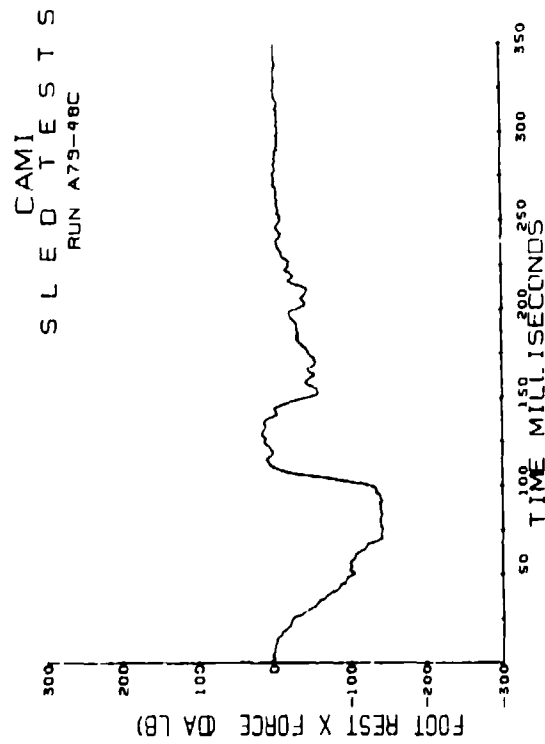
CAMI
S L E D T E S T S
RUN A79-48B



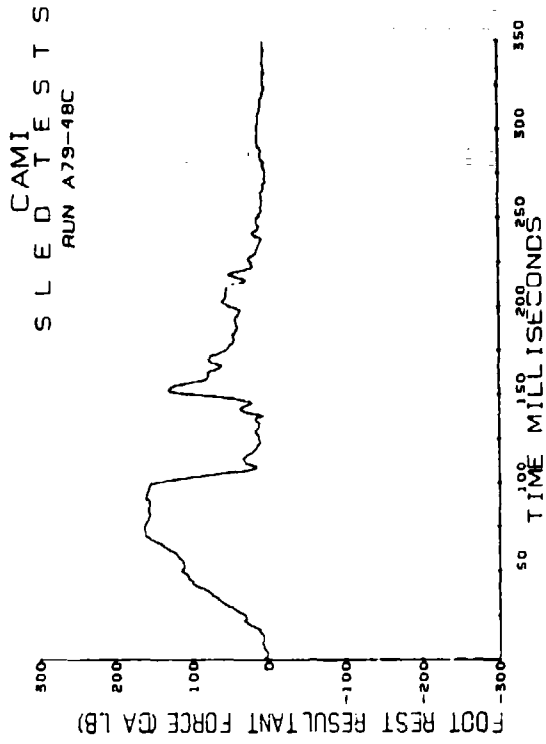
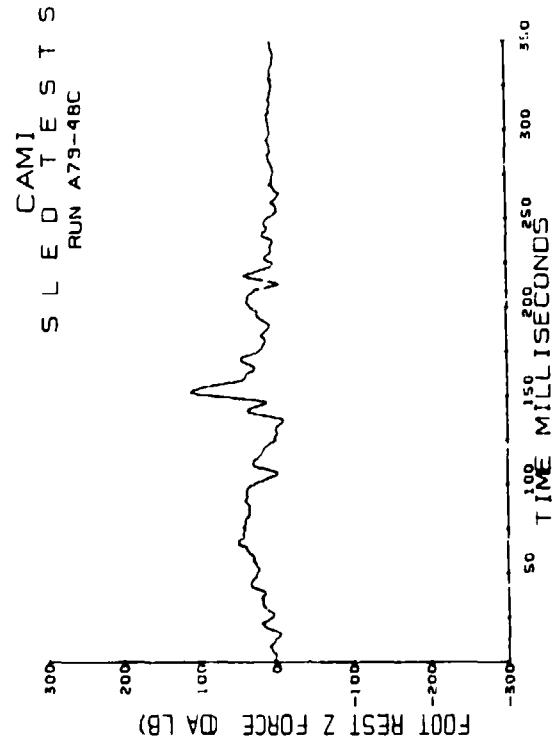
CAMI
S L E D T E S T S
RUN A79-48B



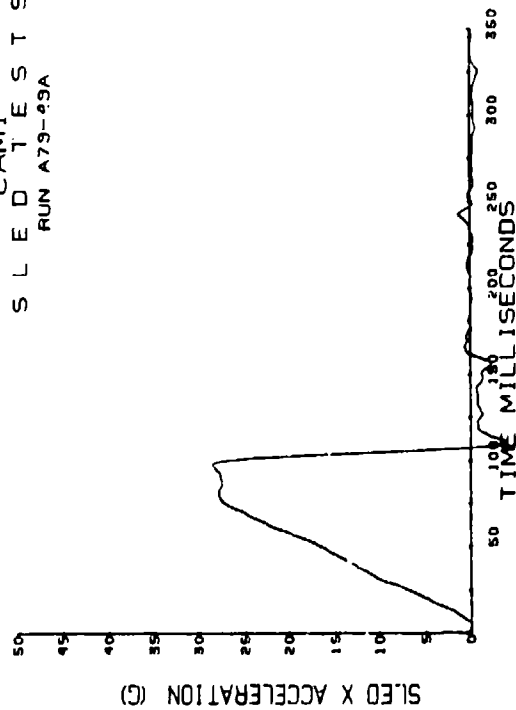




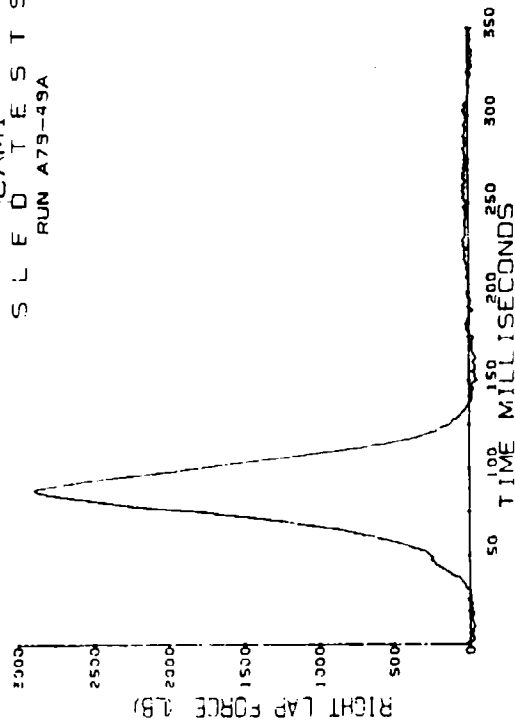
232



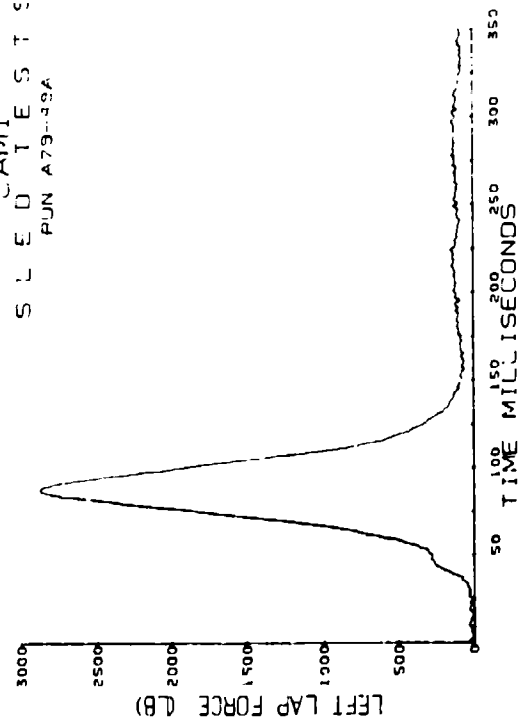
CAMI
S L E D T E S T S
RUN A79-49A



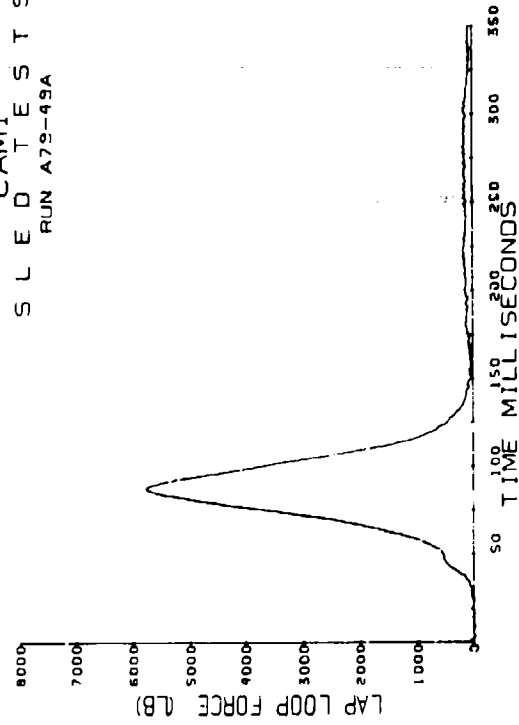
CAMI
S L E D T E S T S
RUN A79-49A



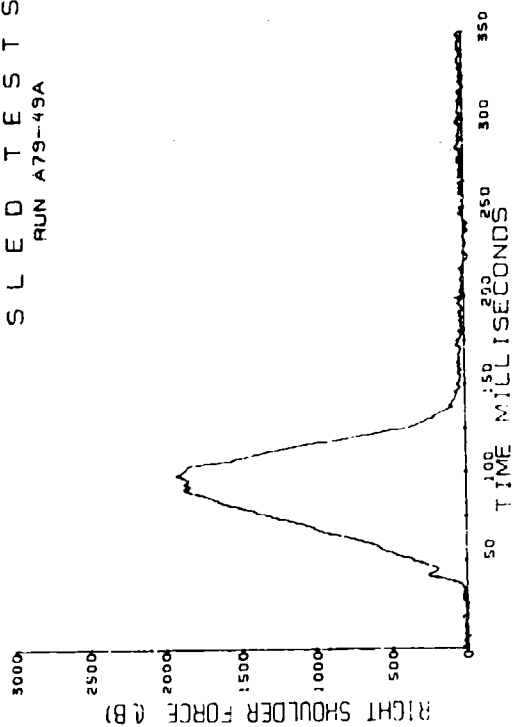
CAMI
S L E D T E S T S
RUN A79-49A



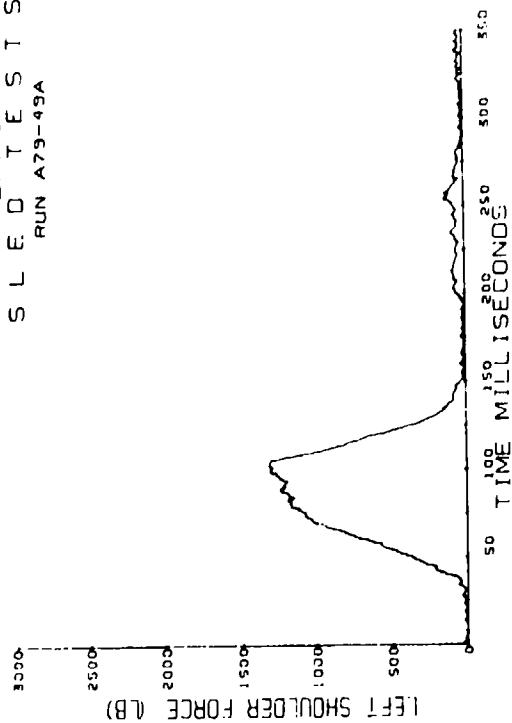
CAMI
S L E D T E S T S
RUN A79-49A



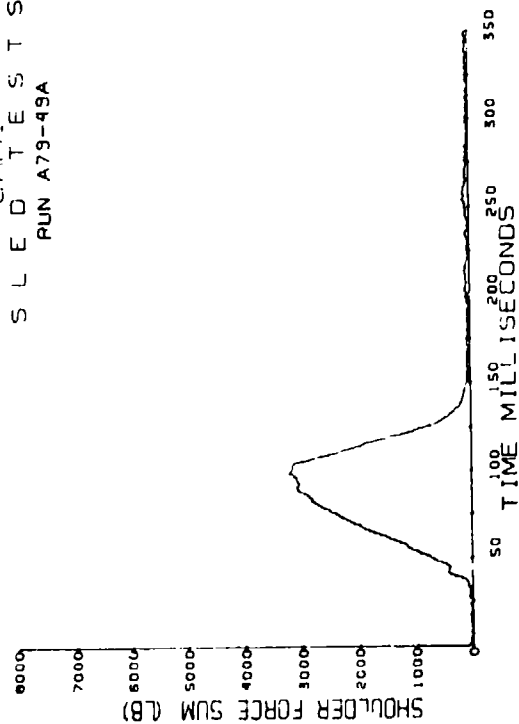
CAMI
S L E D T E S T S
RUN A79-49A



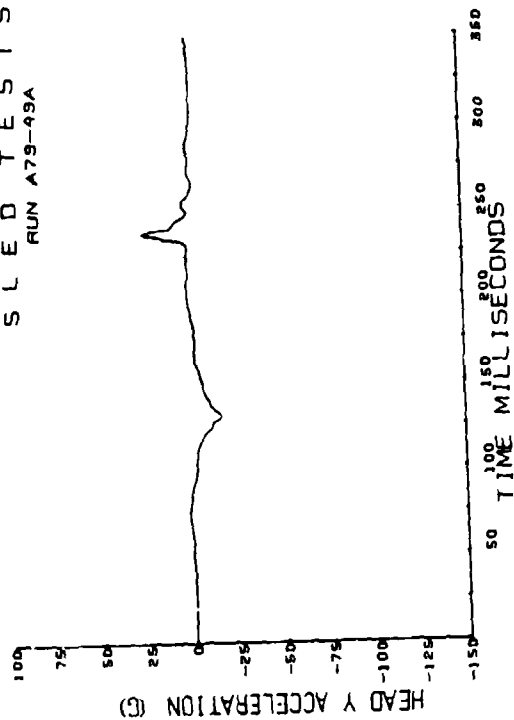
CAMI
S L E D T E S T S
RUN A79-49A



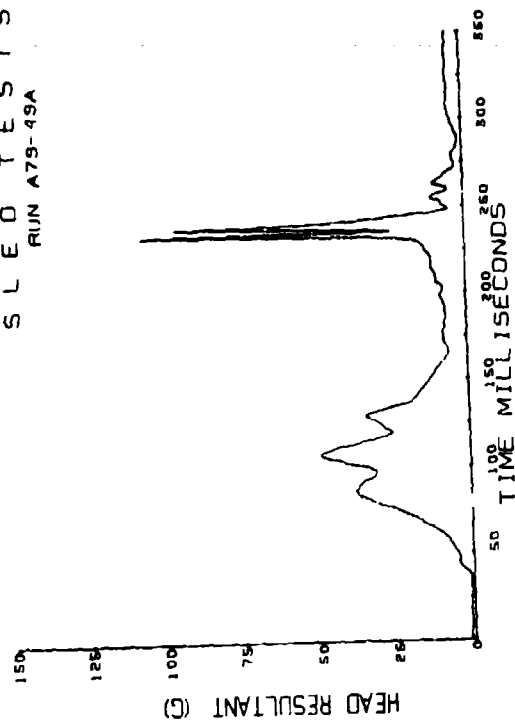
CAMI
S L E D T E S T S
RUN A79-49A



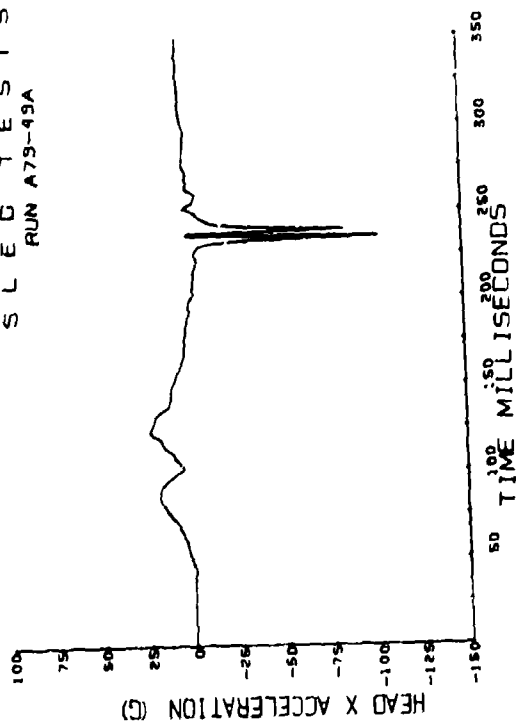
CAMI
S L E D T E S T S
RUN A79-49A



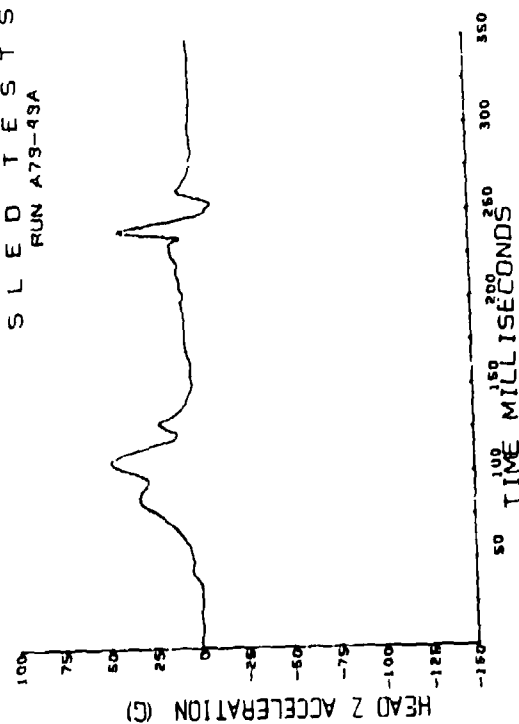
CAMI
S L E D T E S T S
RUN A79-49A



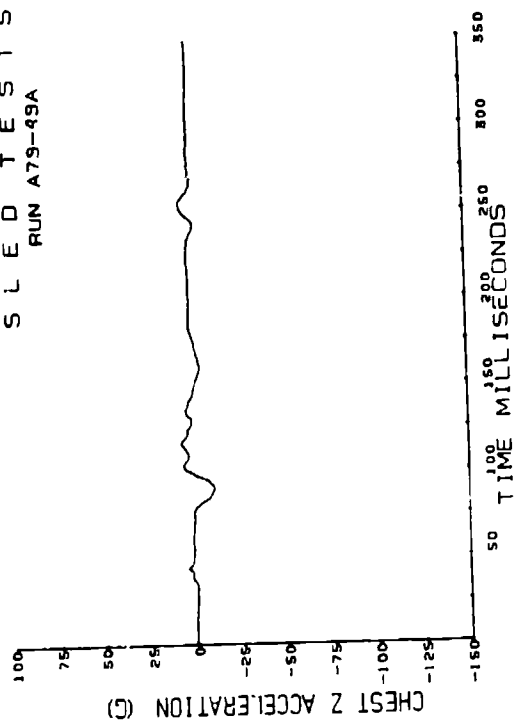
CAMI
S L E D T E S T S
RUN A79-49A



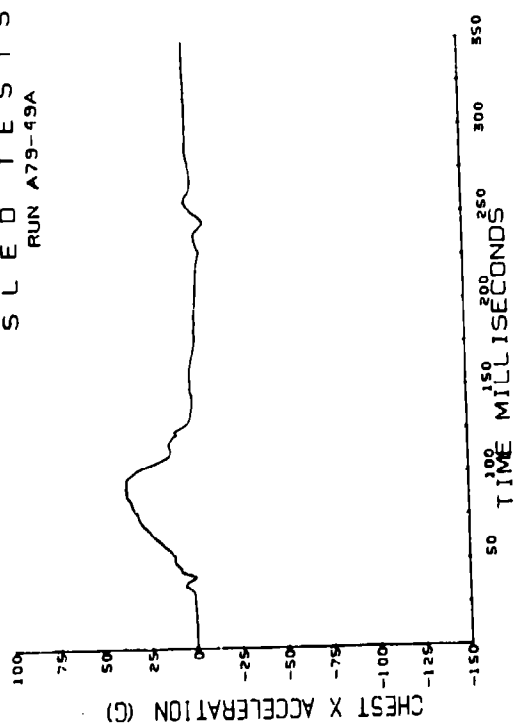
CAMI
S L E D T E S T S
RUN A79-49A



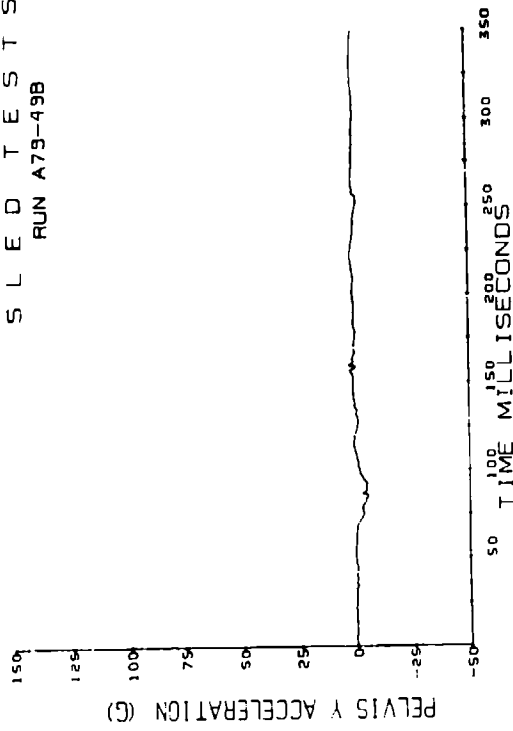
CAMI
S L E D T E S T S
RUN A79-49A



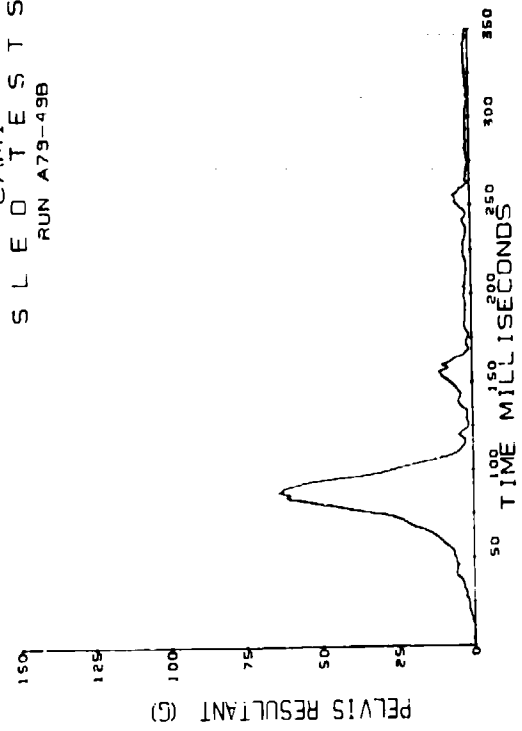
CAMI
S L E D T E S T S
RUN A79-49A



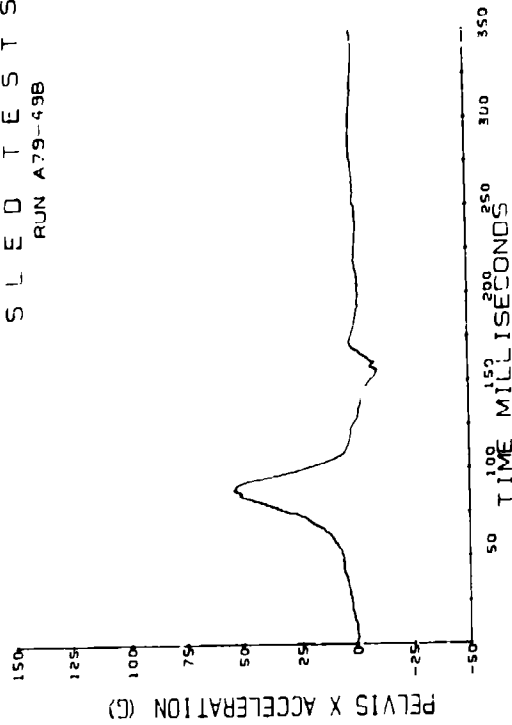
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S L E D T E S T S
RUN A79-49B



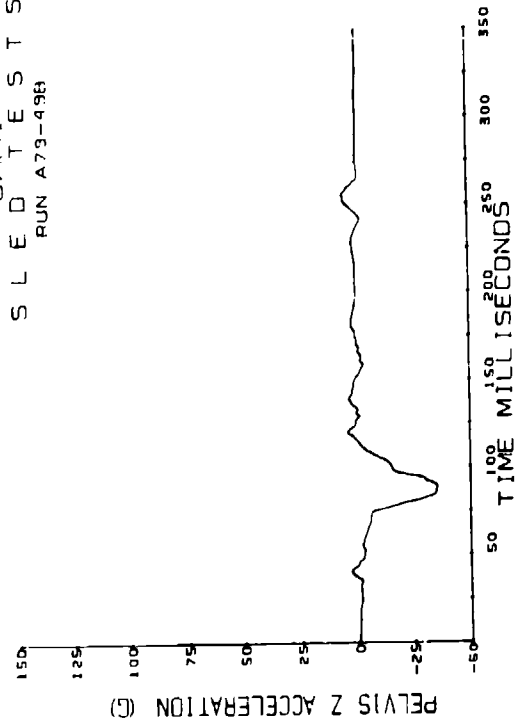
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S L E D T E S T S
RUN A79-49B

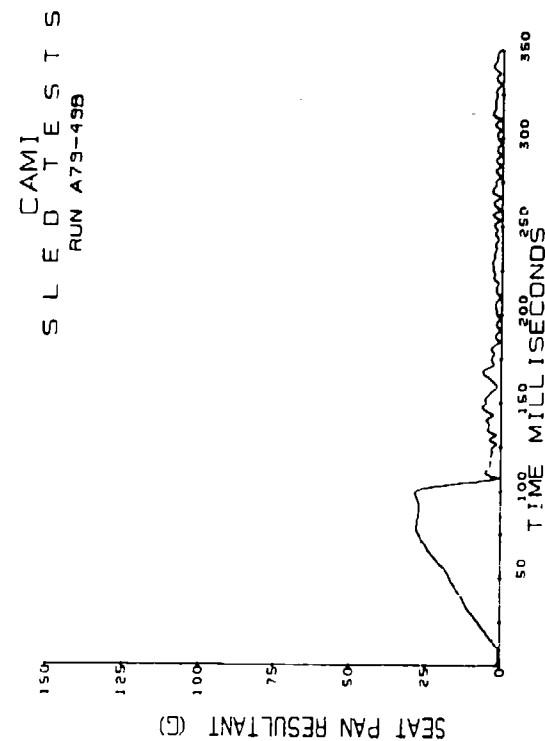
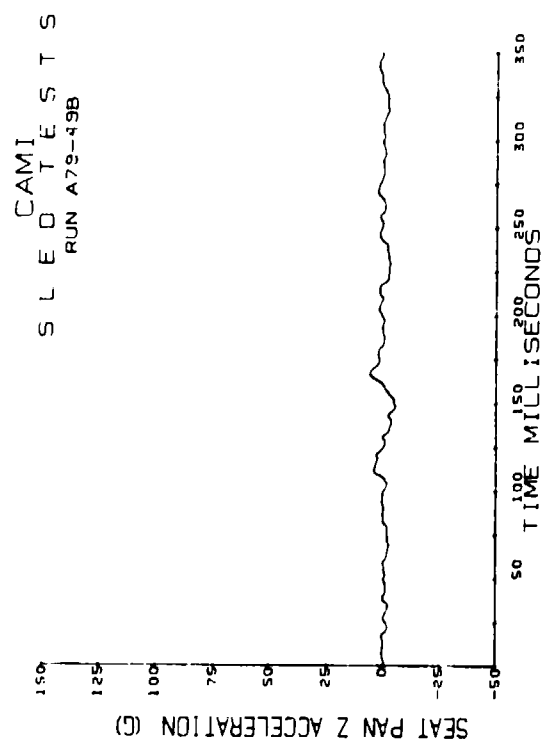
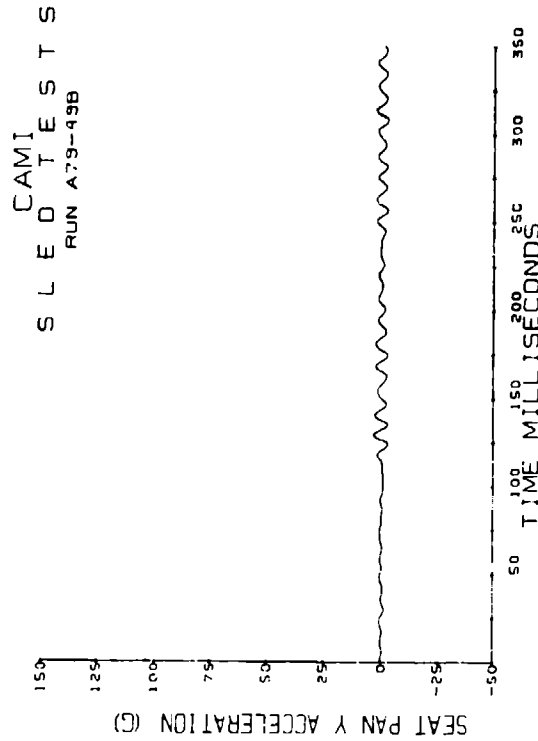
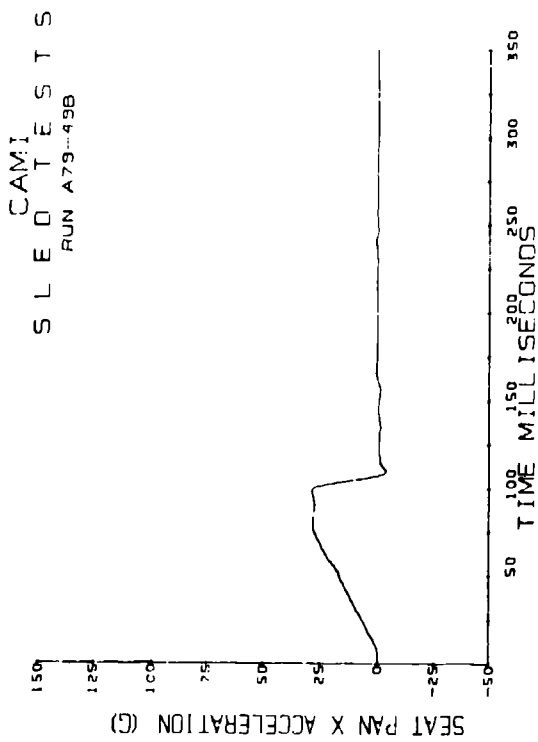


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S L E D T E S T S
RUN A79-49B

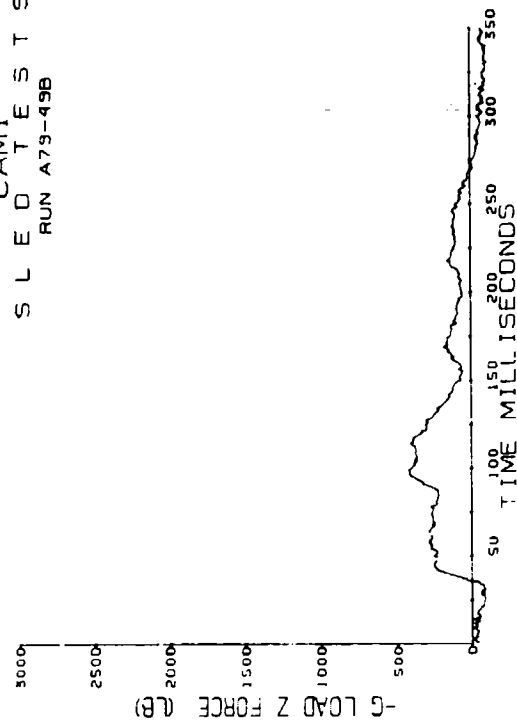


CAMI
S L E D T E S T S
RUN A79-49B

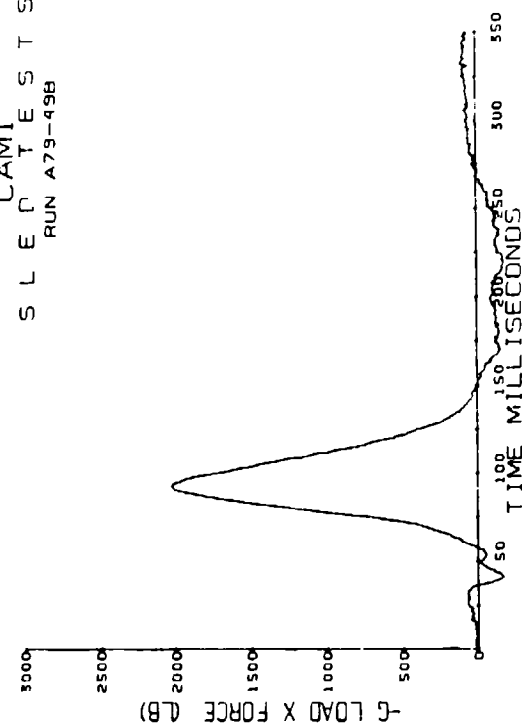


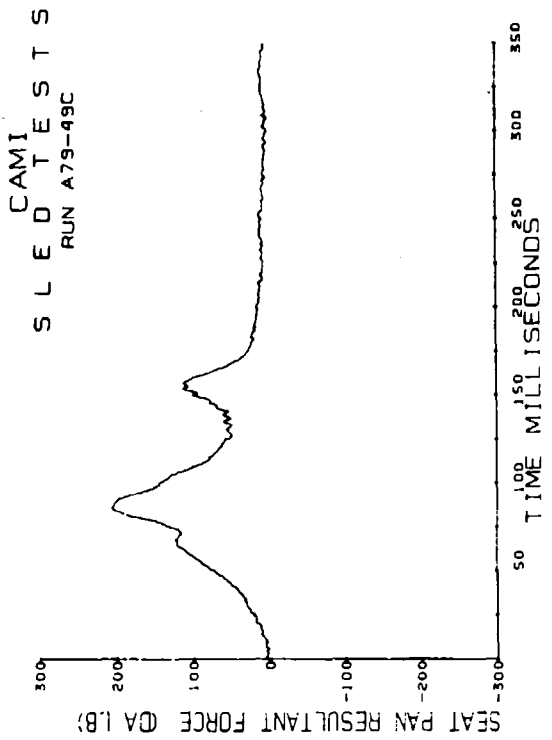
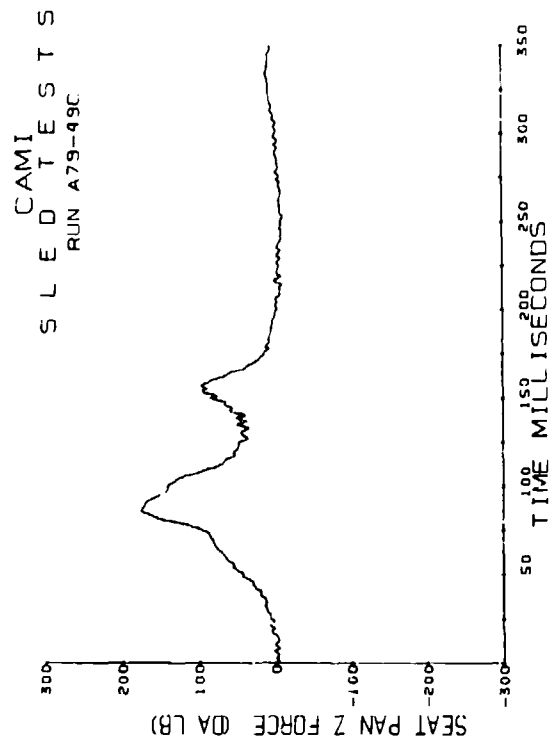
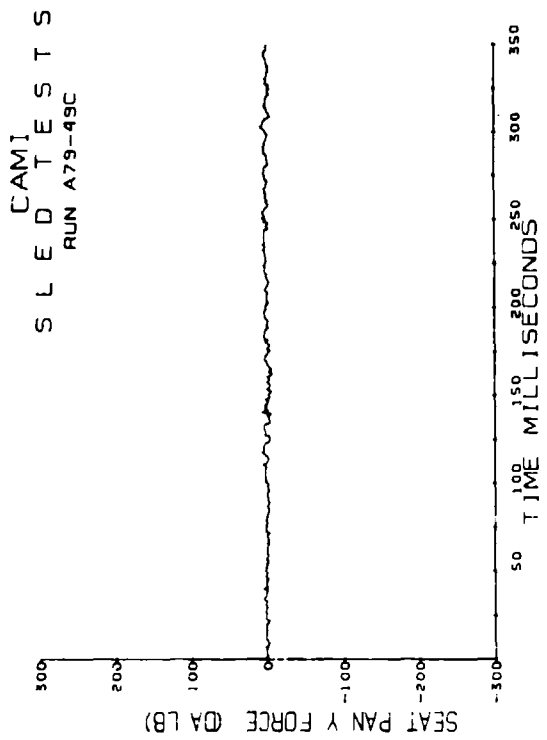
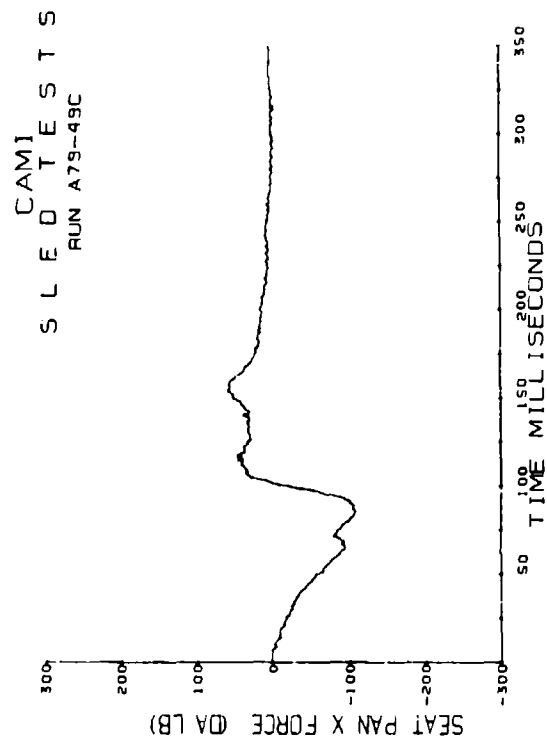


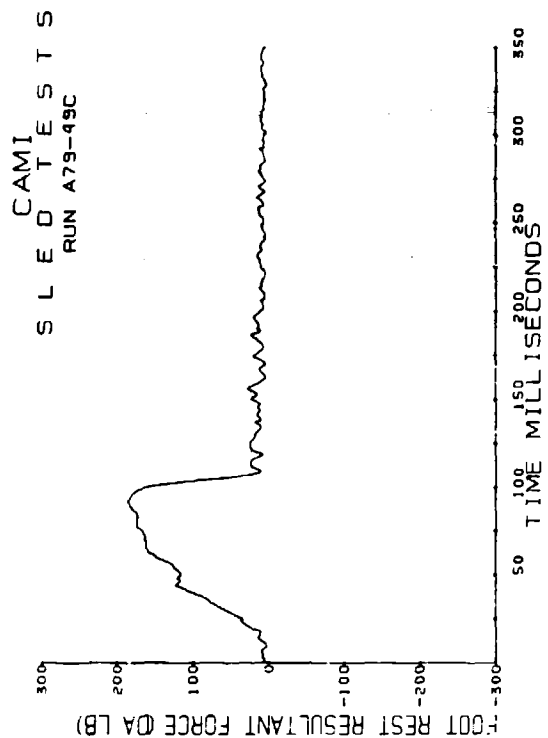
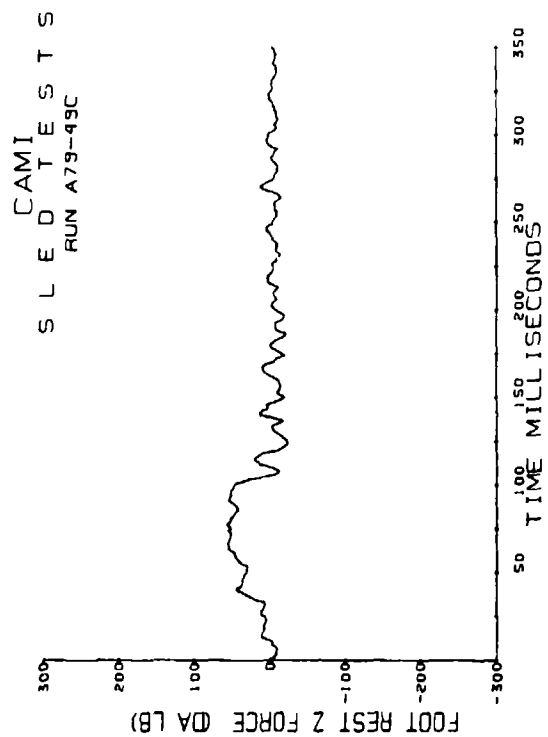
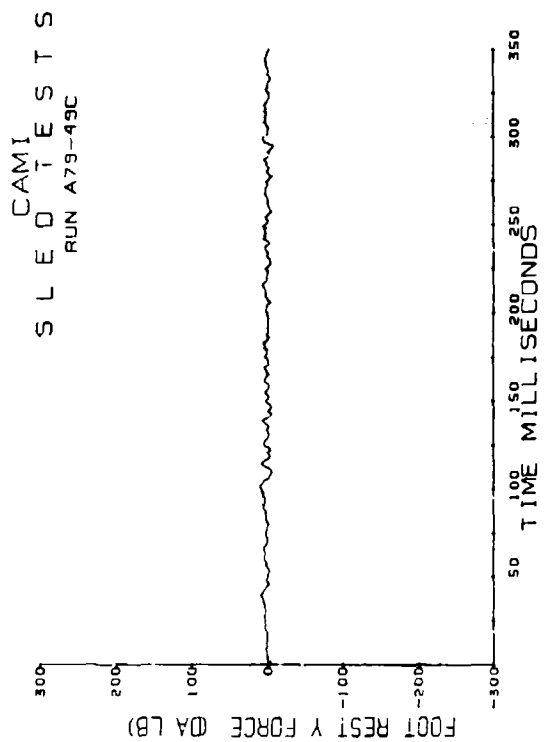
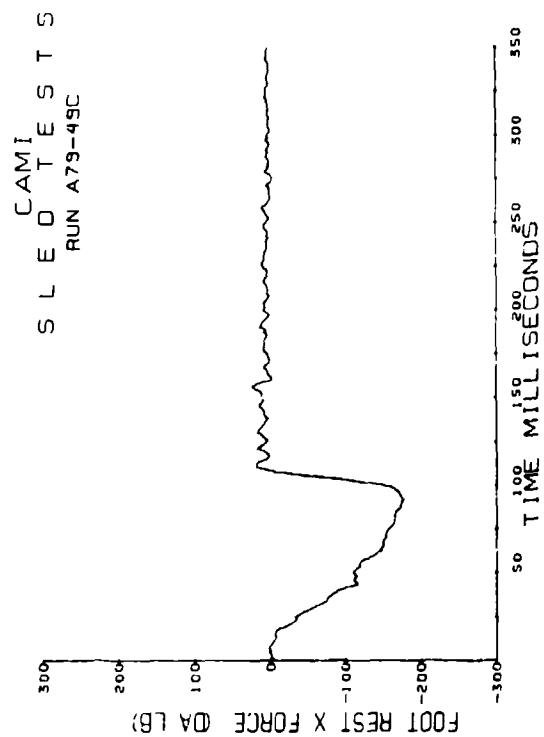
CAMI
S L E D T E S T S
RUN A79-49B



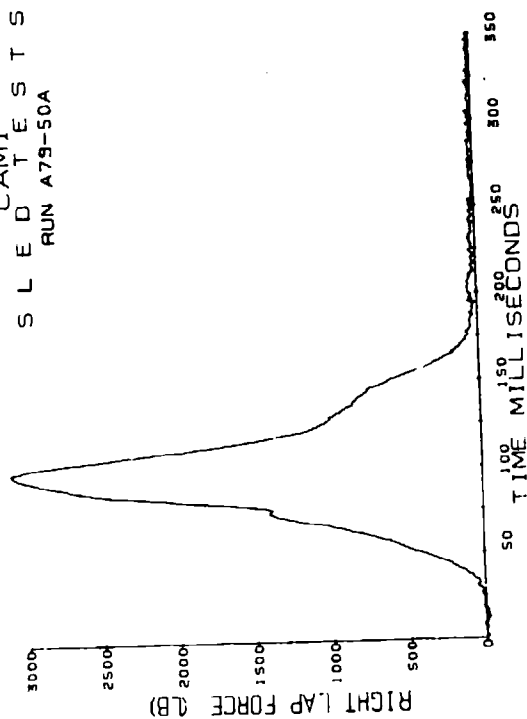
CAMI
S L E D T E S T S
RUN A79-49B



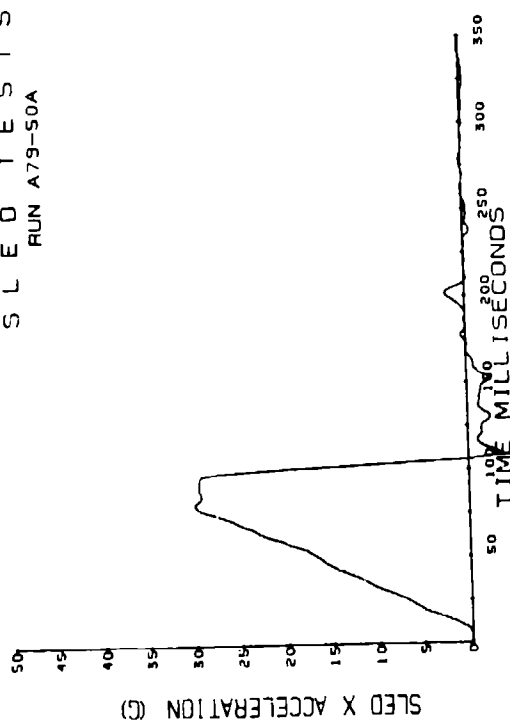




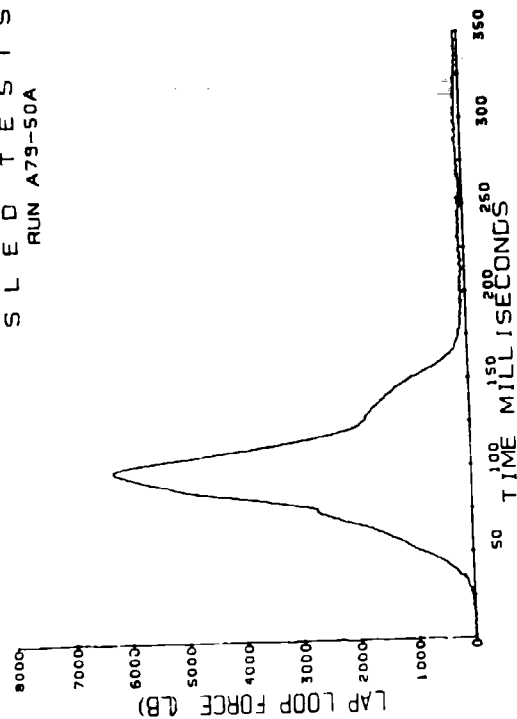
CAMI
S L E D T E S T S
RUN A79-50A



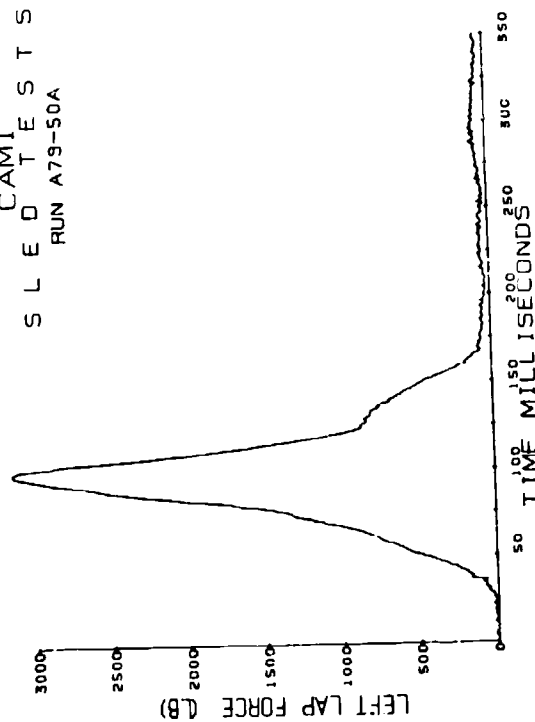
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S L E D T E S T S
RUN A79-50A

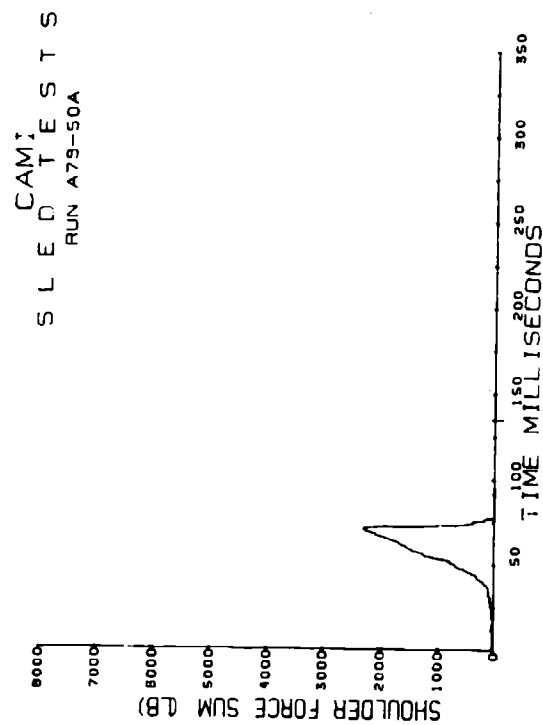
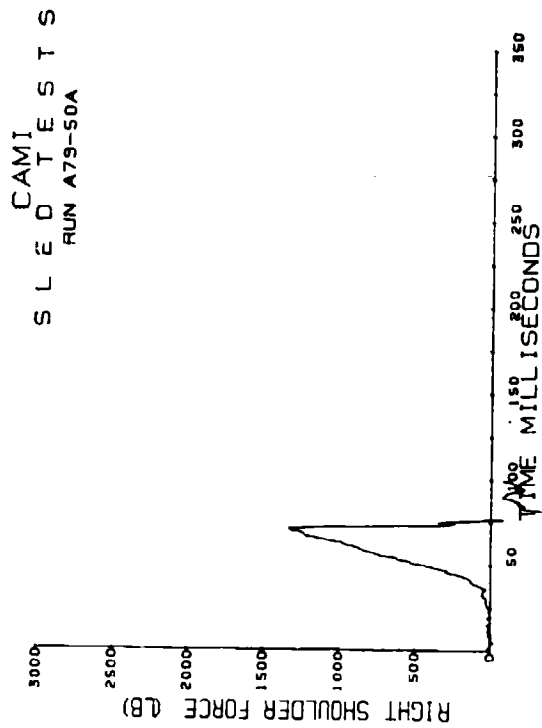
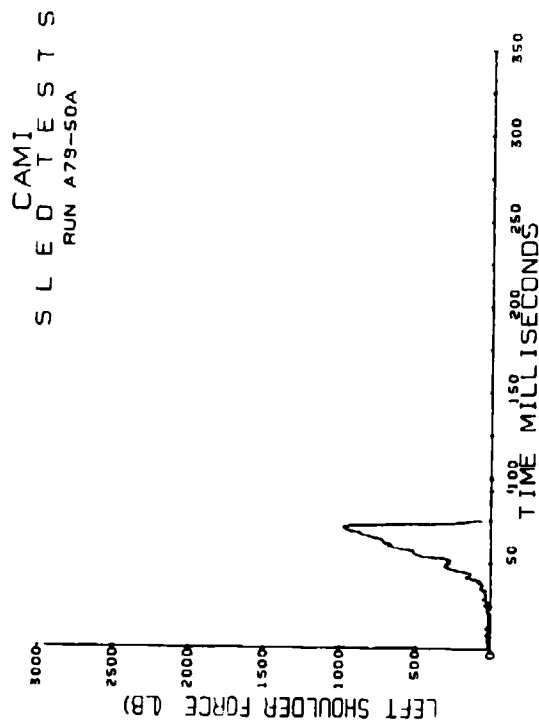


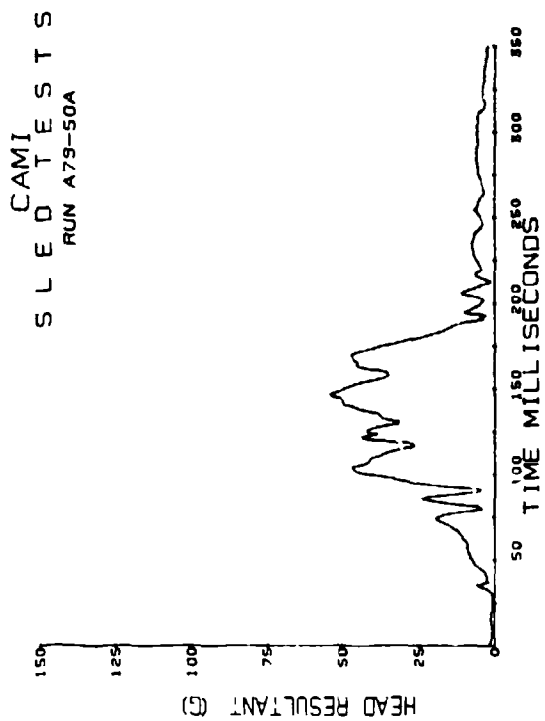
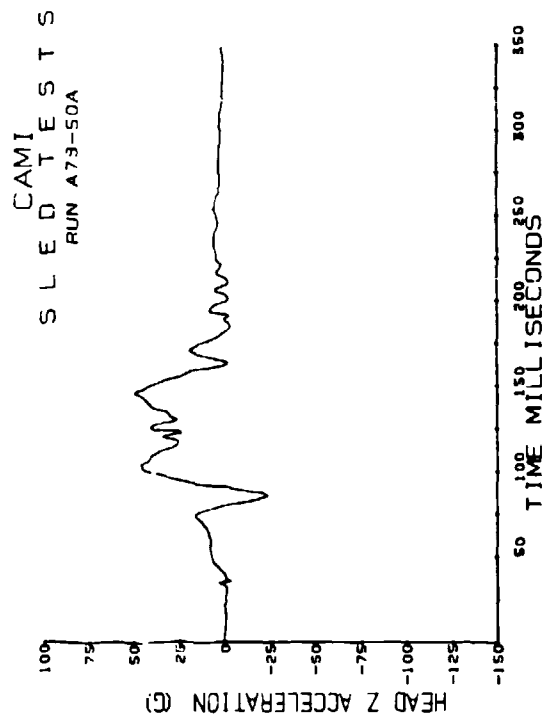
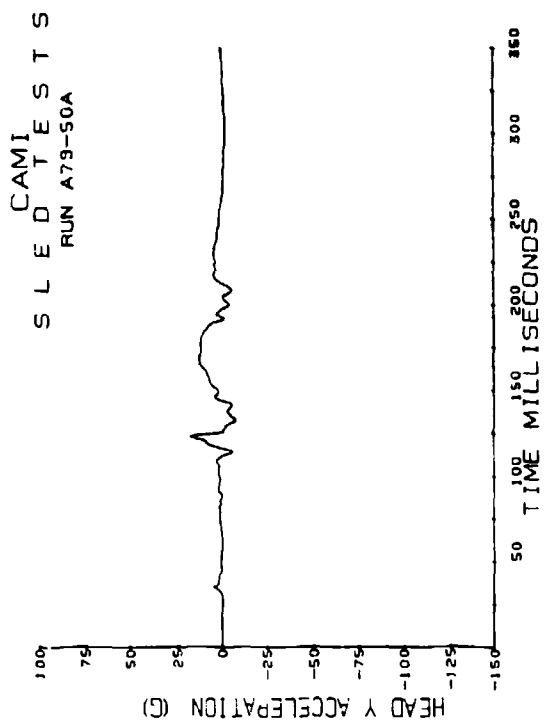
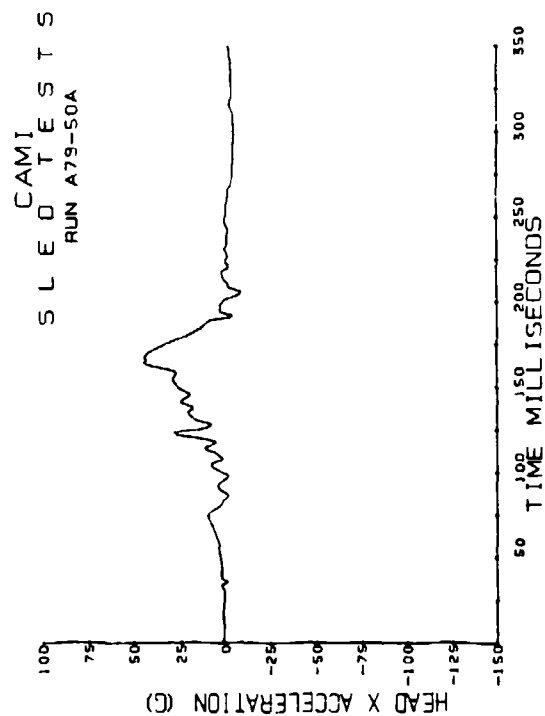
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S L E D T E S T S
RUN A79-50A



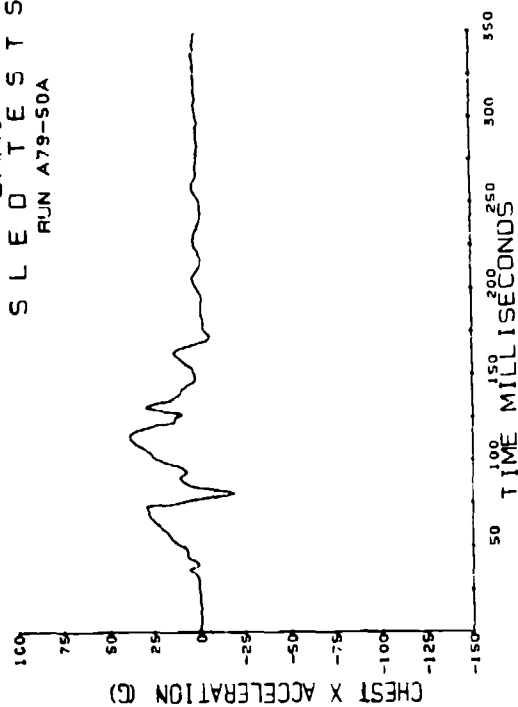
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S L E D T E S T S
RUN A79-50A



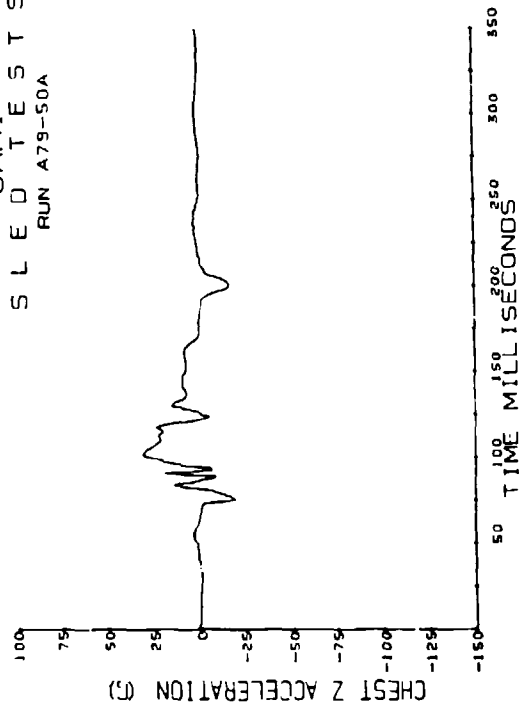




CAMI
S L E D T E S T S
RUN A79-50A

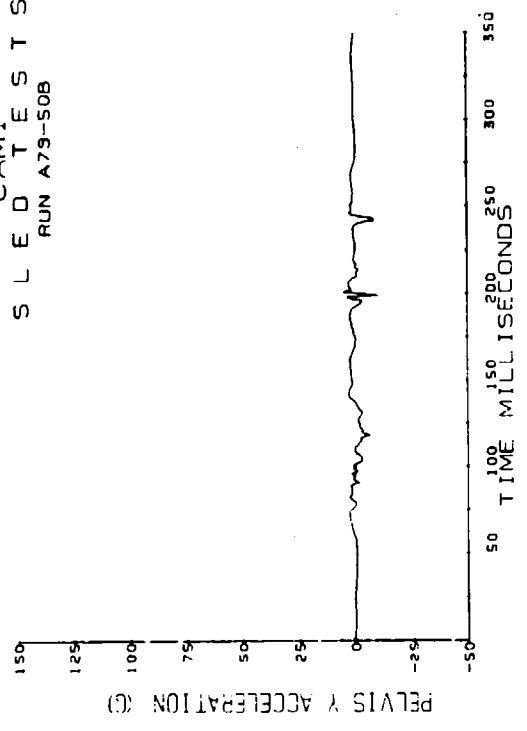
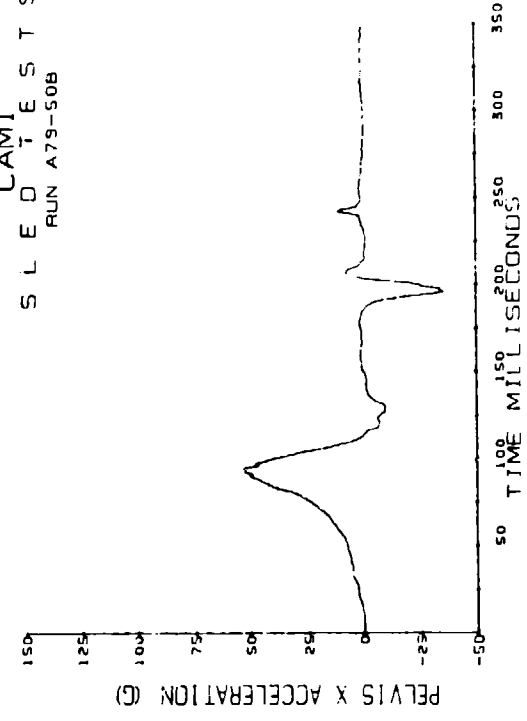


CAMI
S L E D T E S T S
RUN A79-50A



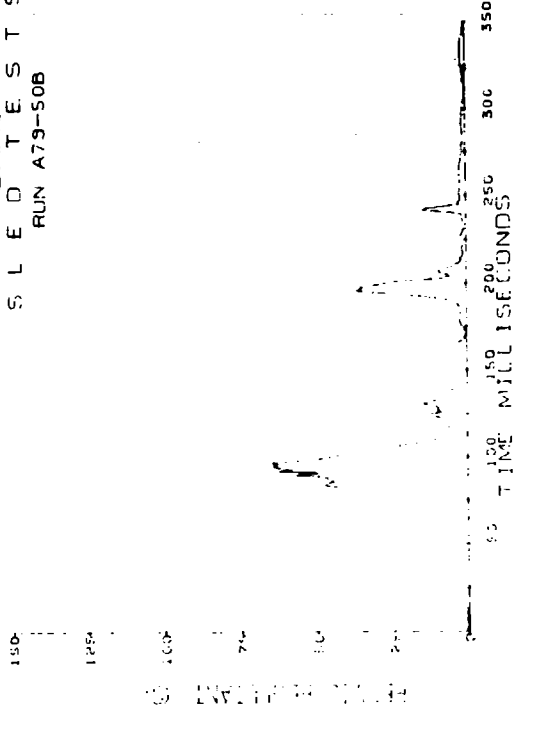
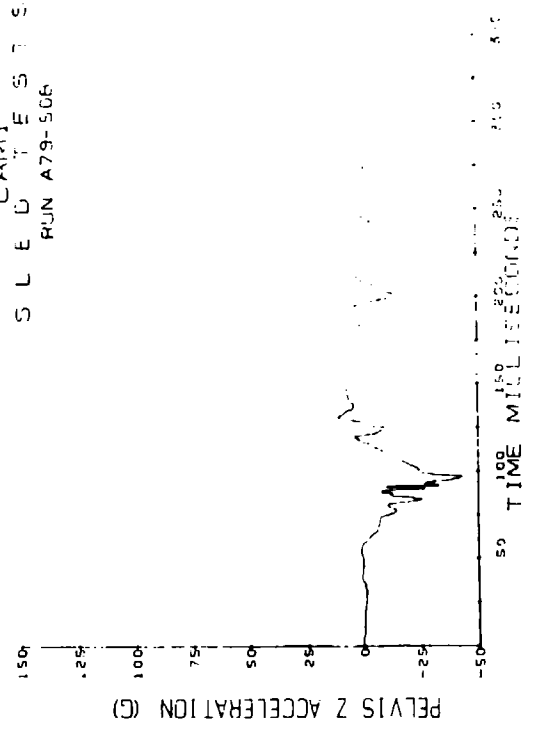
CAMI
S L E D T E S T S
RUN A79-50B

CAMI
S L E D T E S T S
RUN A79-50B

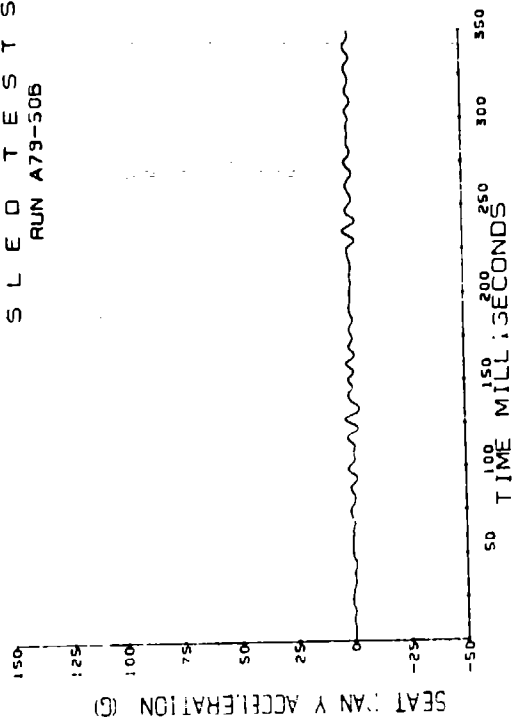


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S L E D T E S T S
RUN A79-50B

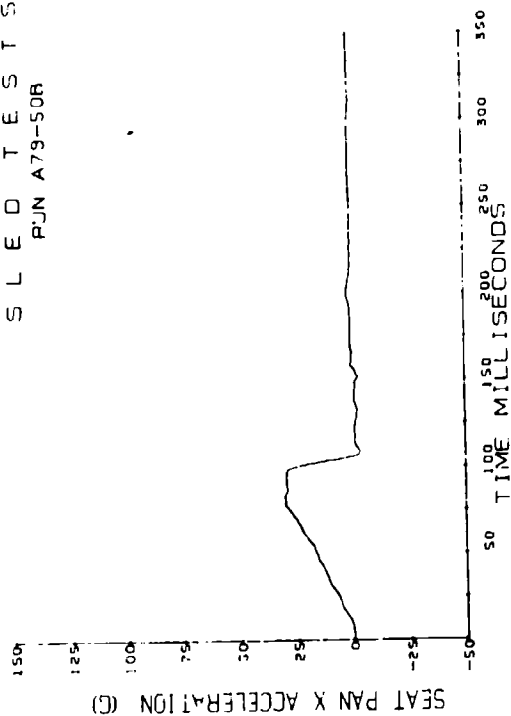
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S L E D T E S T S
RUN A79-50B



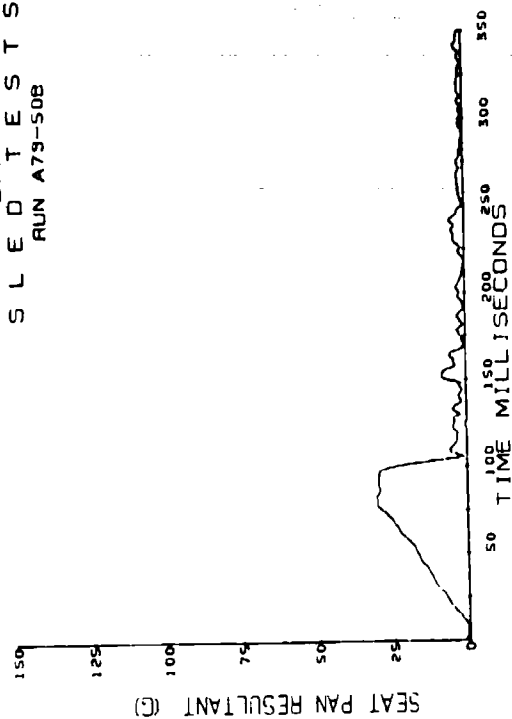
CAMI
S L E D T E S T S
RUN A79-50B



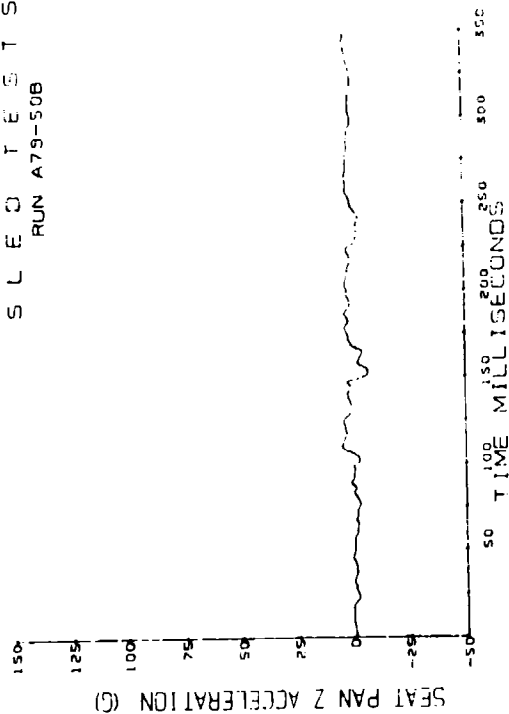
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S L E D T E S T S
RUN A79-50B



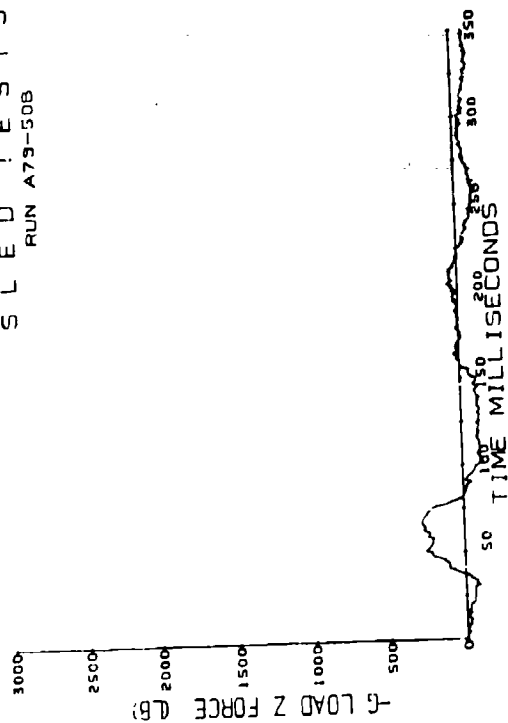
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S L E D T E S T S
RUN A79-50B



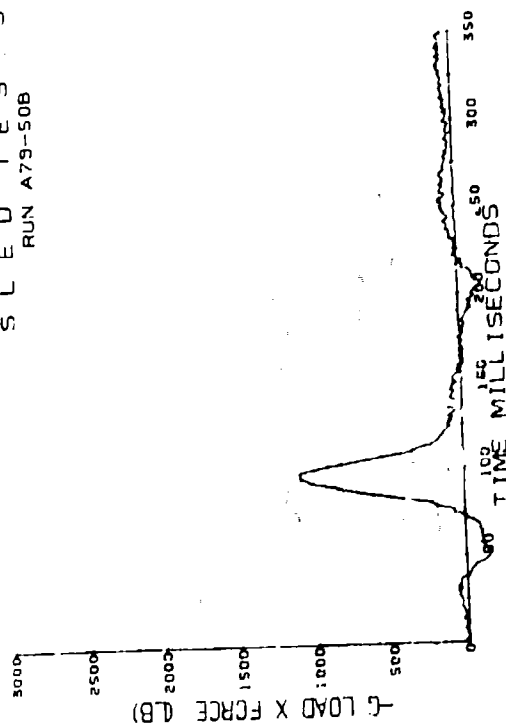
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S L E D T E S T S
RUN A79-50B

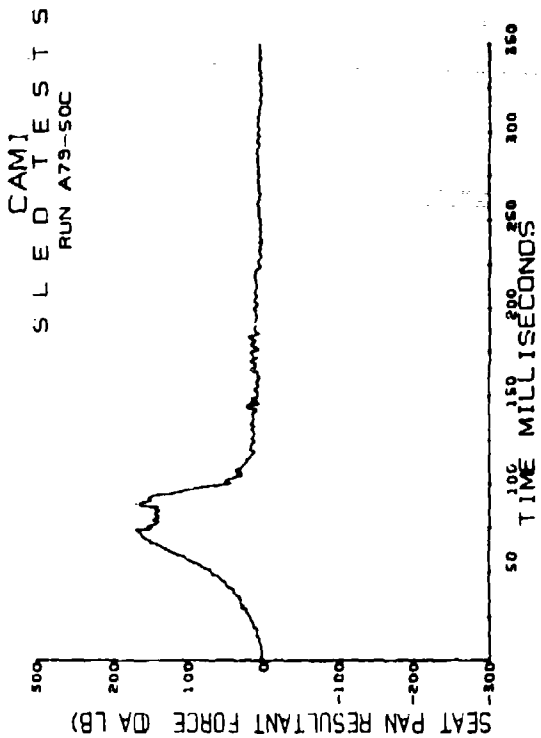
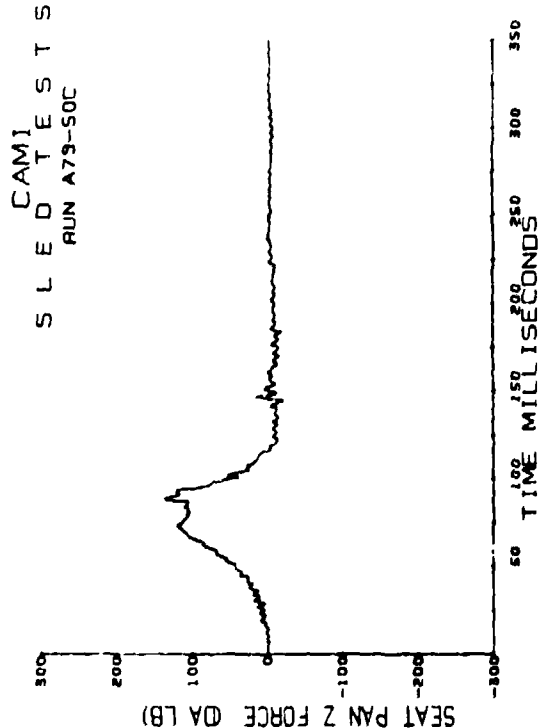
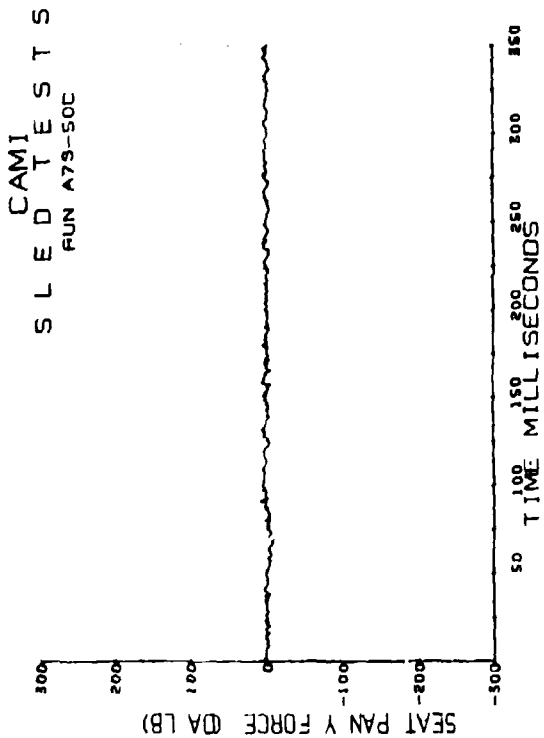
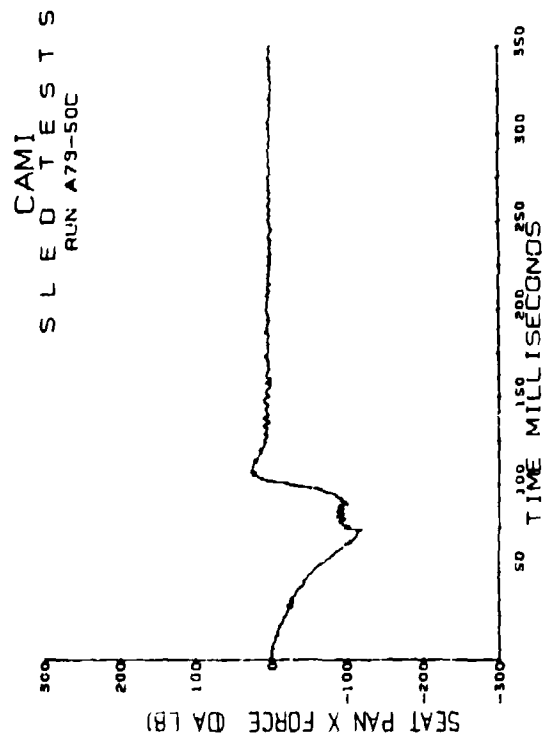


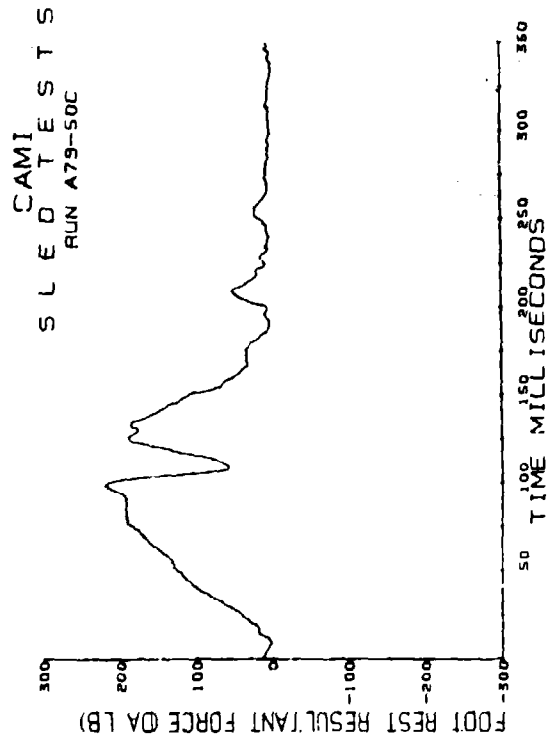
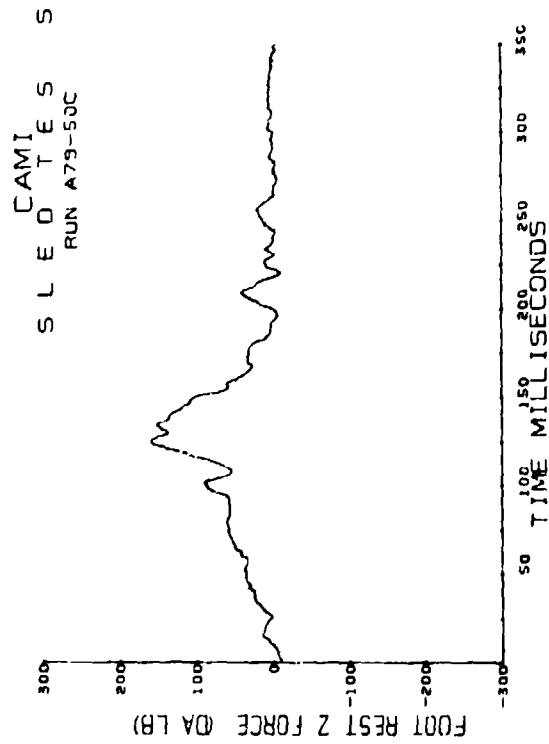
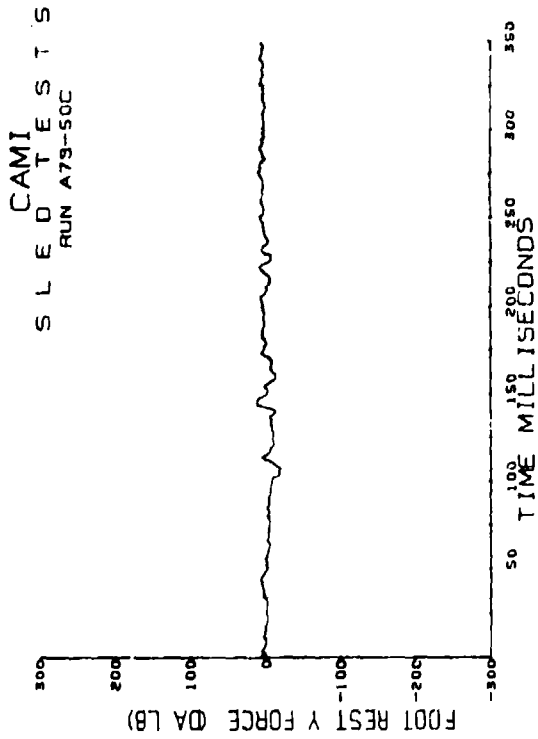
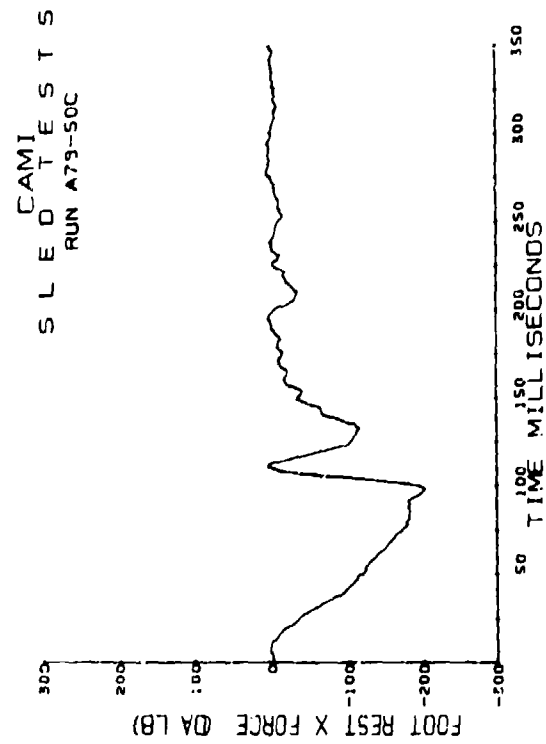
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S L E D T E S T S
RUN A79-50B



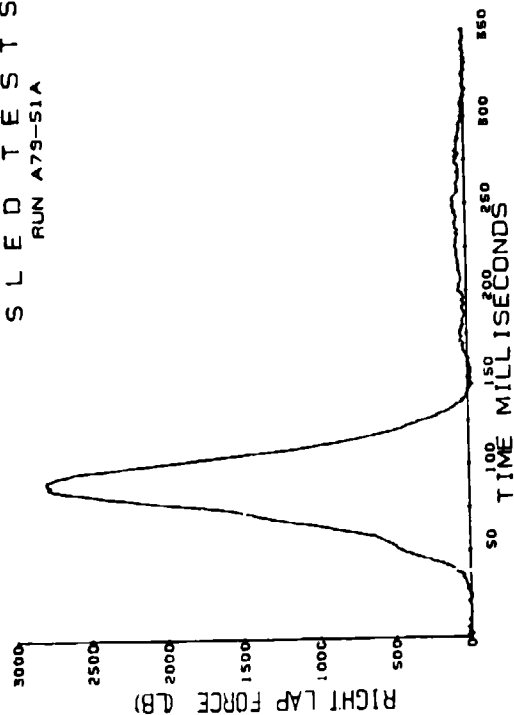
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S L E D T E S T S
RUN A79-50B



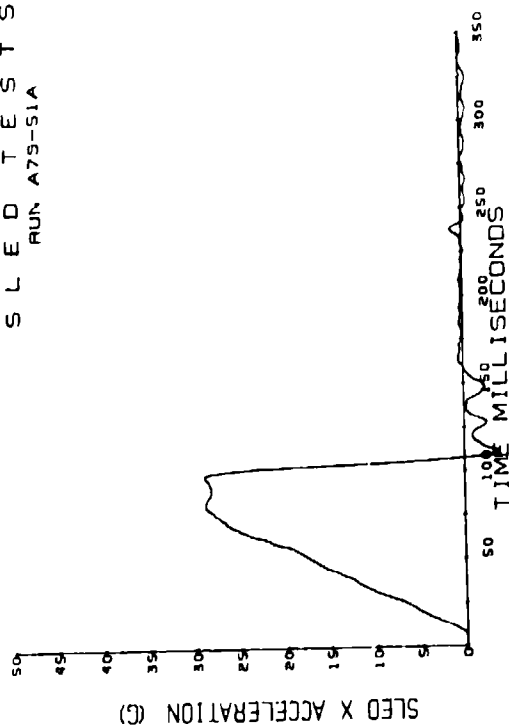




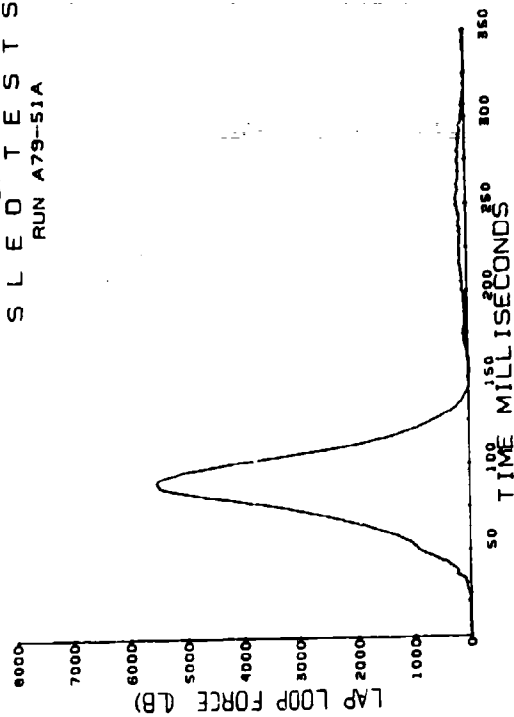
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S L E D T E S T S
RUN A79-51A



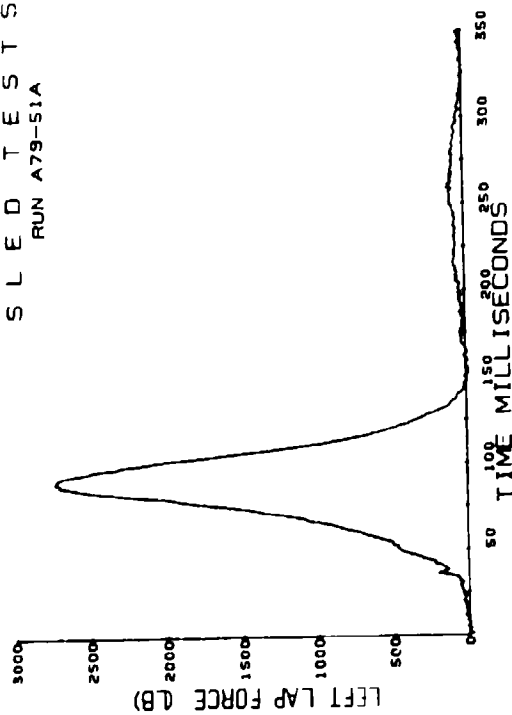
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S L E D T E S T S
RUN A79-51A



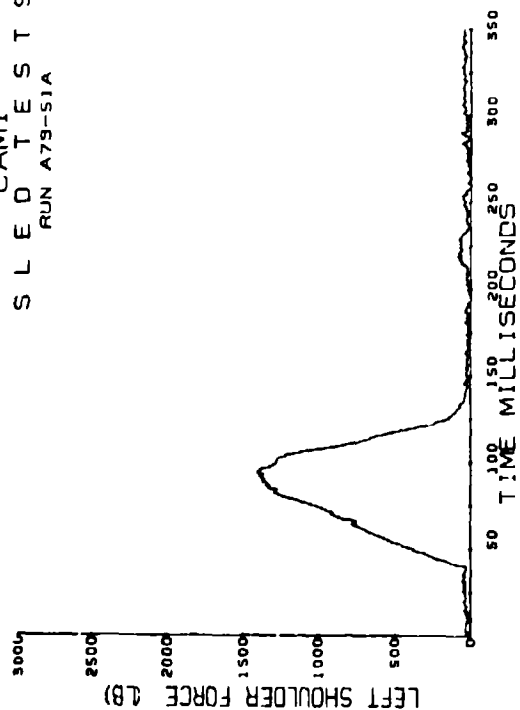
CAMI
S L E D T E S T S
RUN A79-51A



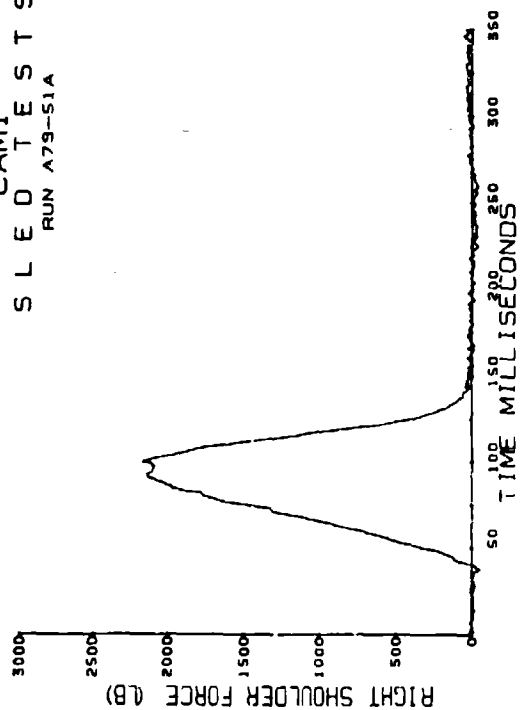
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S L E D T E S T S
RUN A79-51A



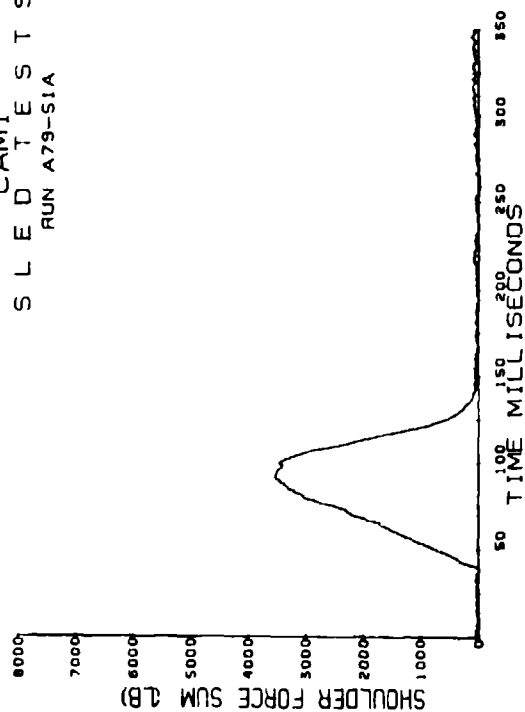
CAMI
S L E D T E S T S
RUN A79-S1A

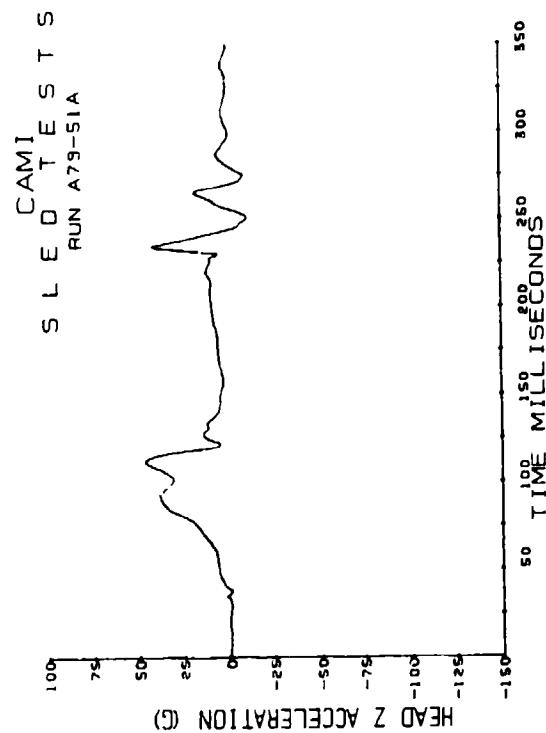
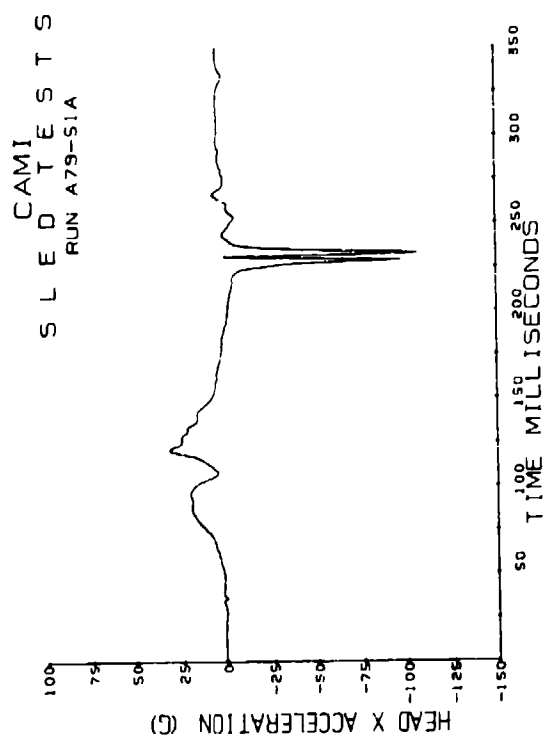
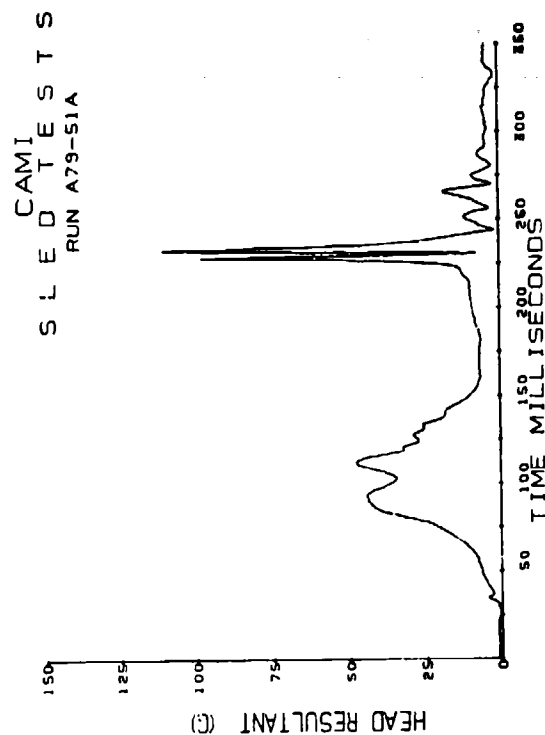
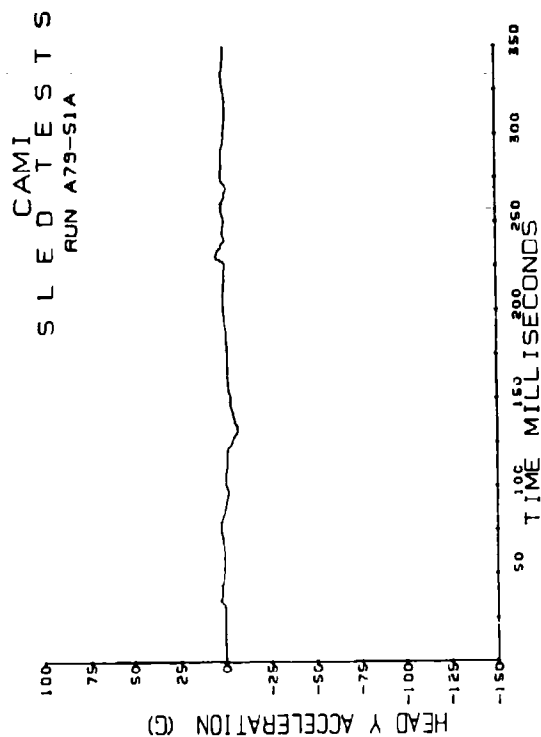


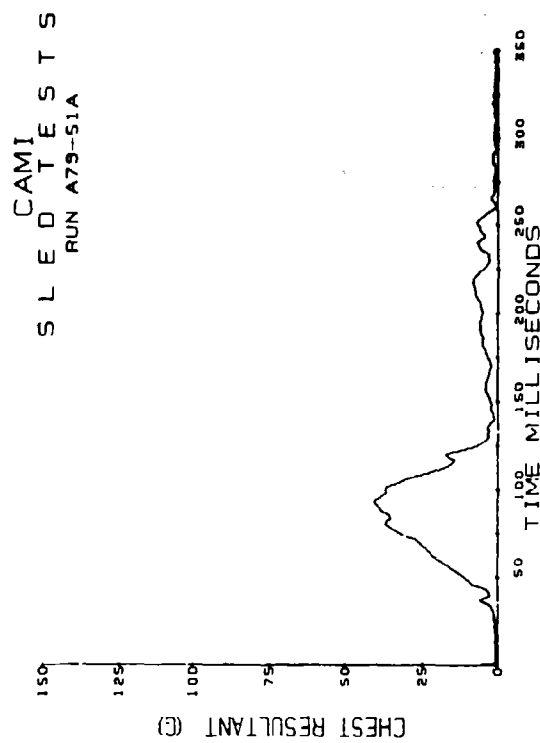
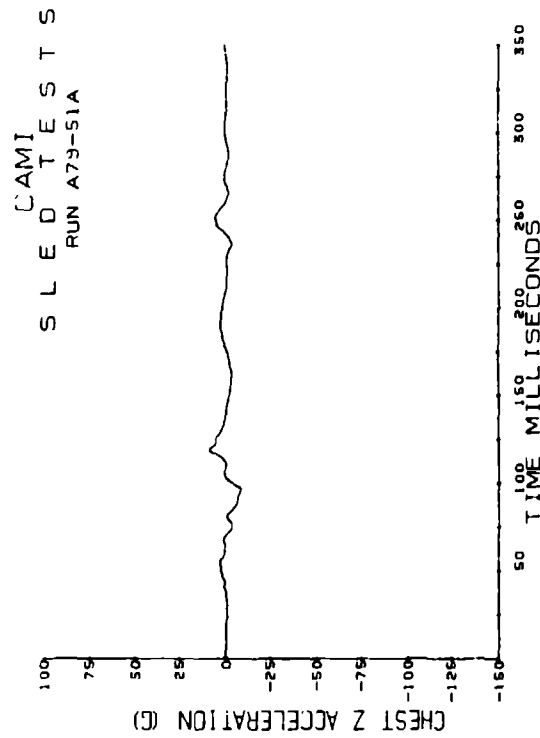
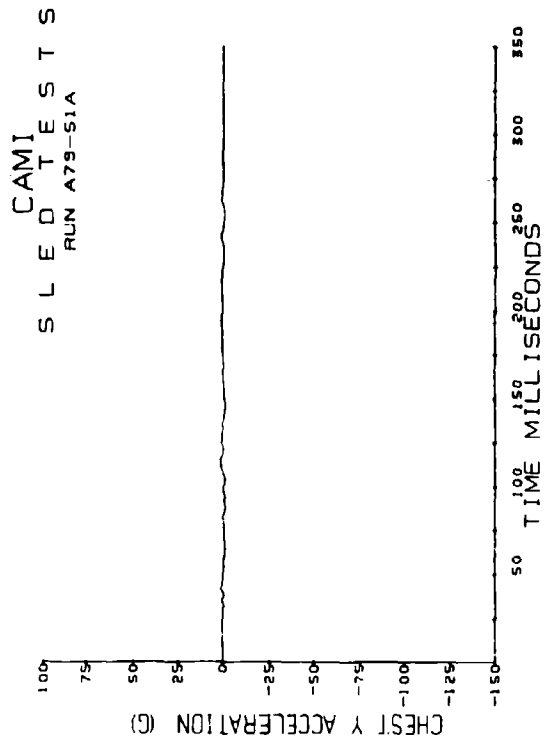
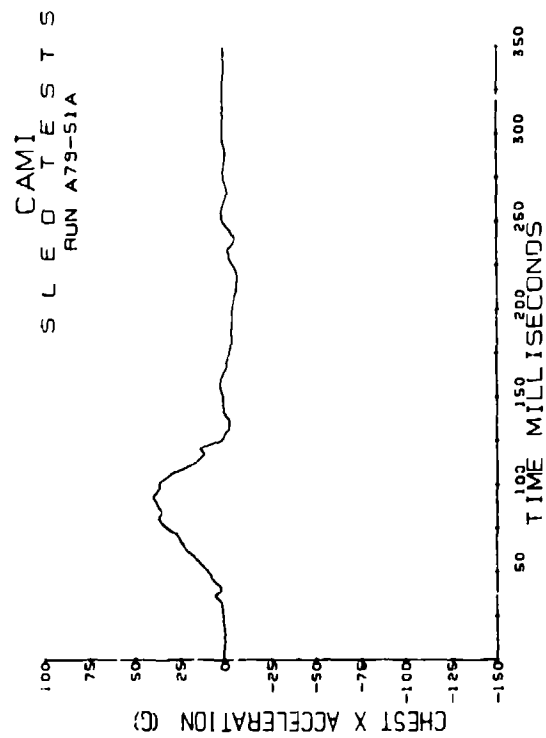
CAMI
S L E D T E S T S
RUN A79-S1A

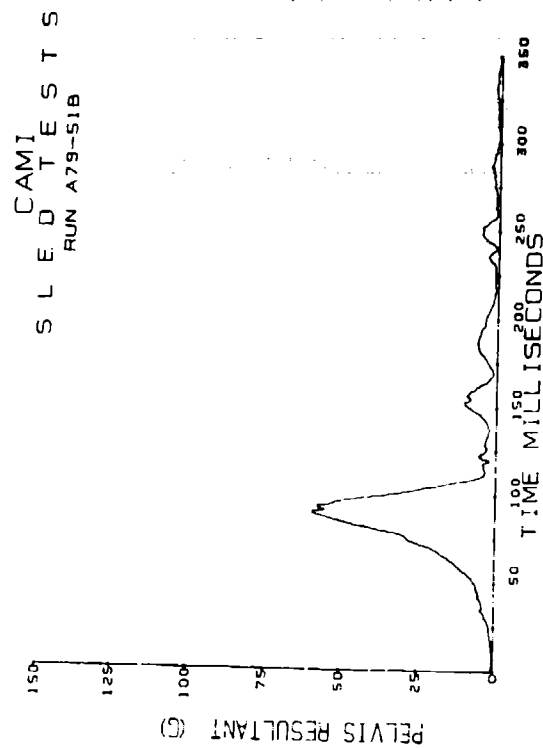
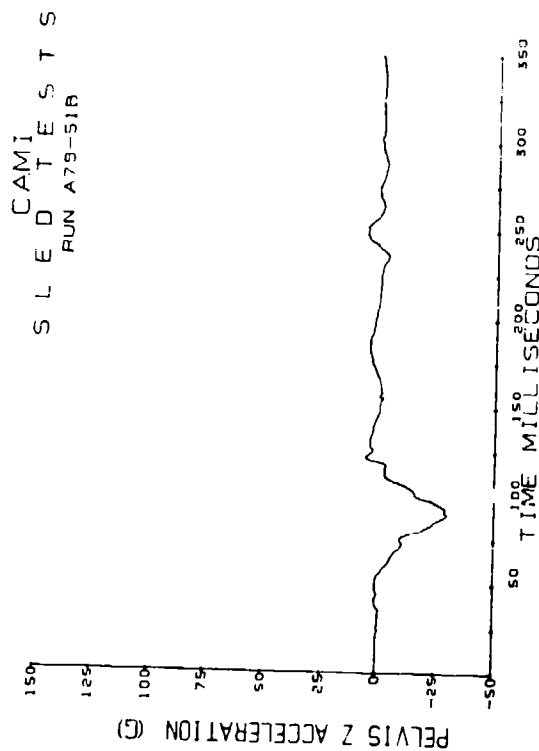
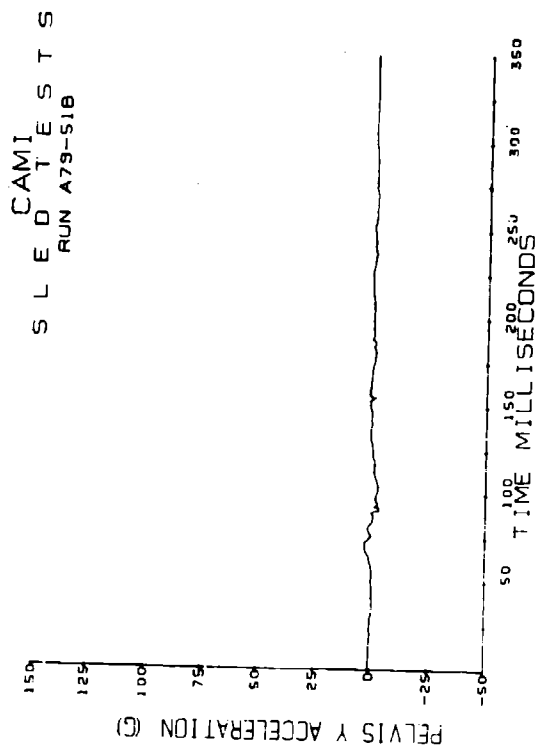
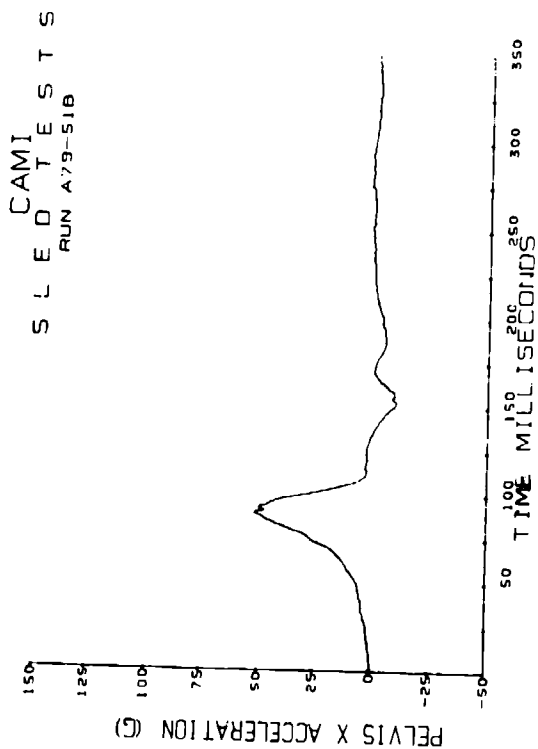


CAMI
S L E D T E S T S
RUN A79-S1A

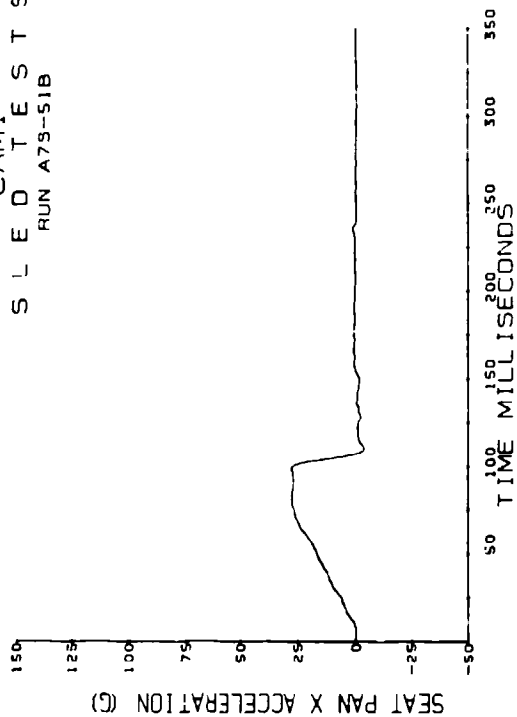




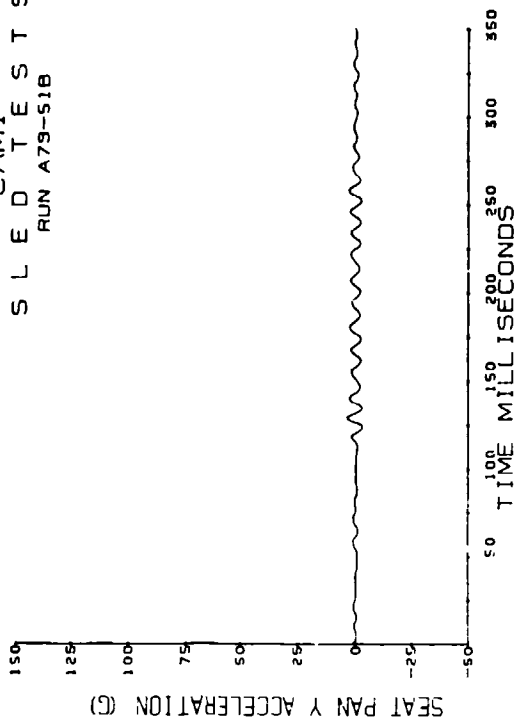




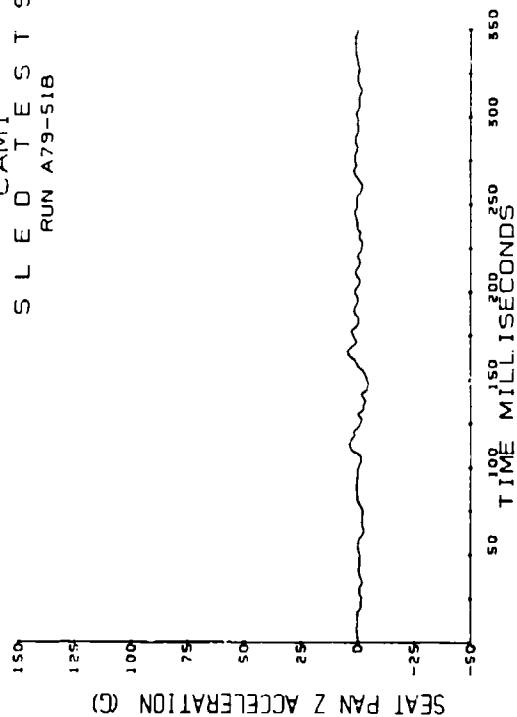
CAMI
S L E D T E S T S
RUN A79-51B



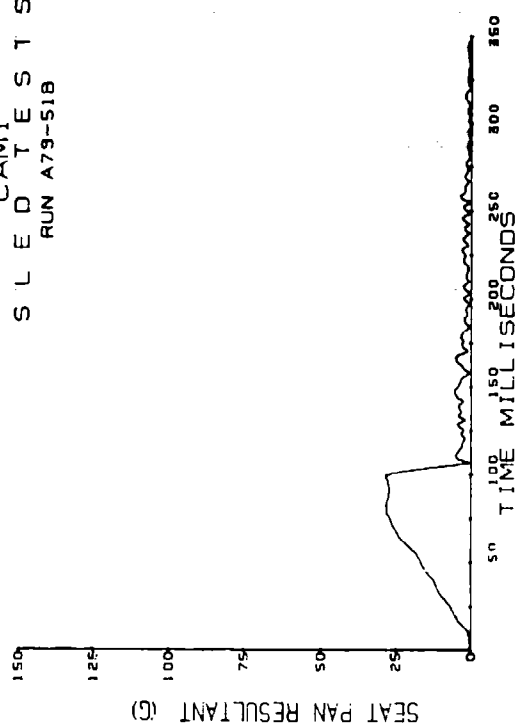
CAMI
S L E D T E S T S
RUN A79-51B



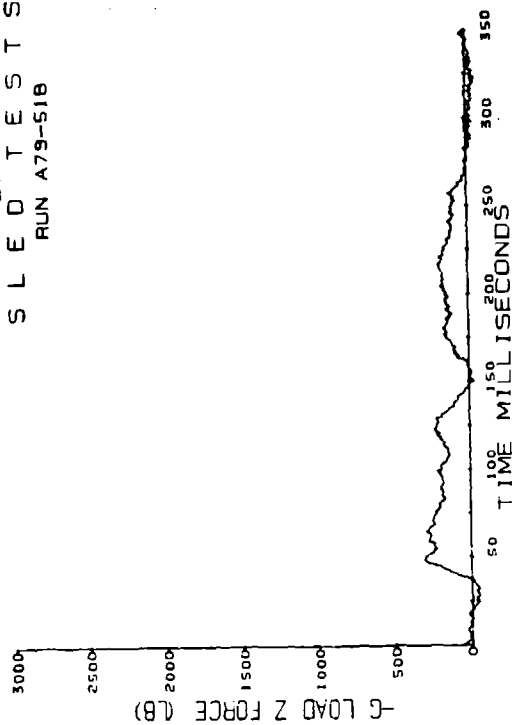
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S L E D T E S T S
RUN A79-51B



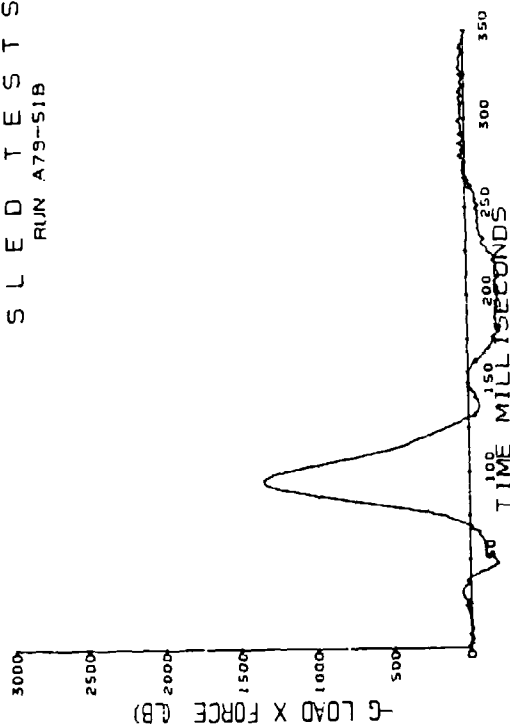
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S L E D T E S T S
RUN A79-51B

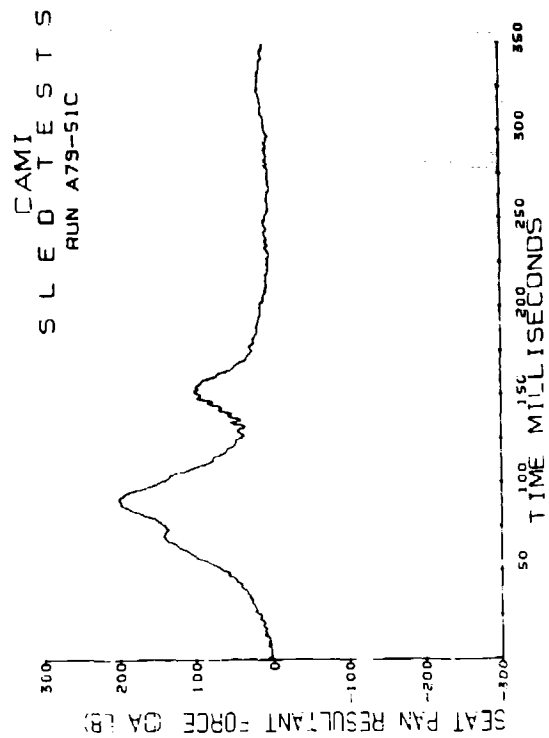
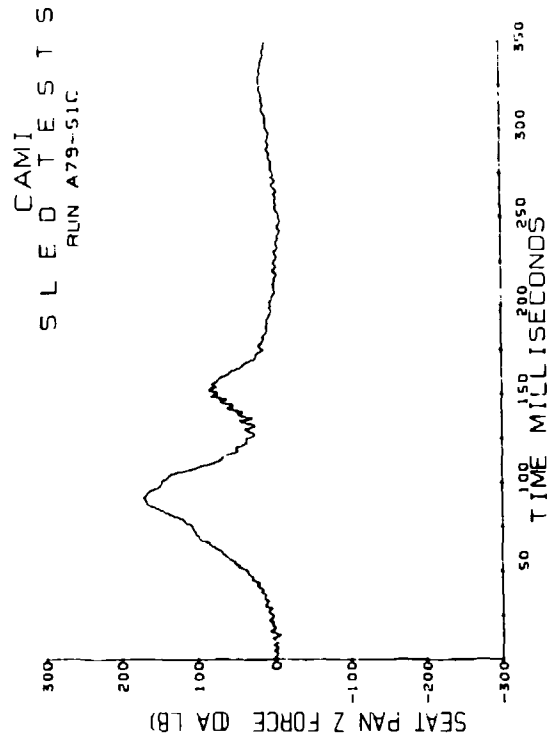
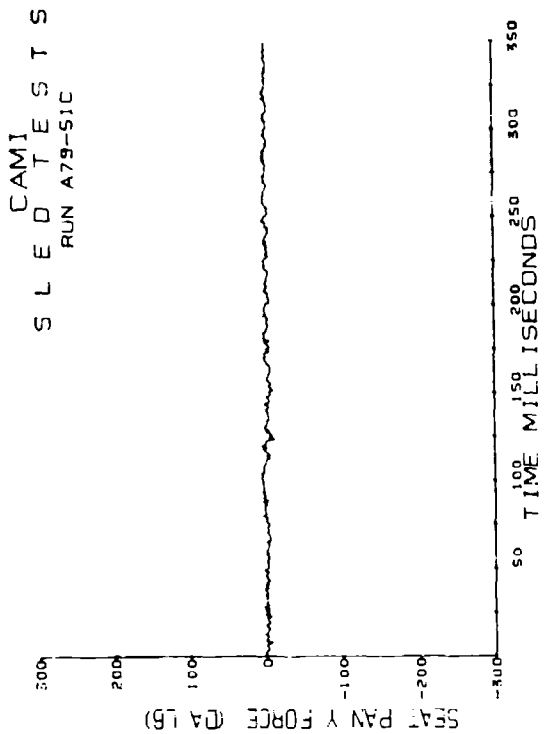
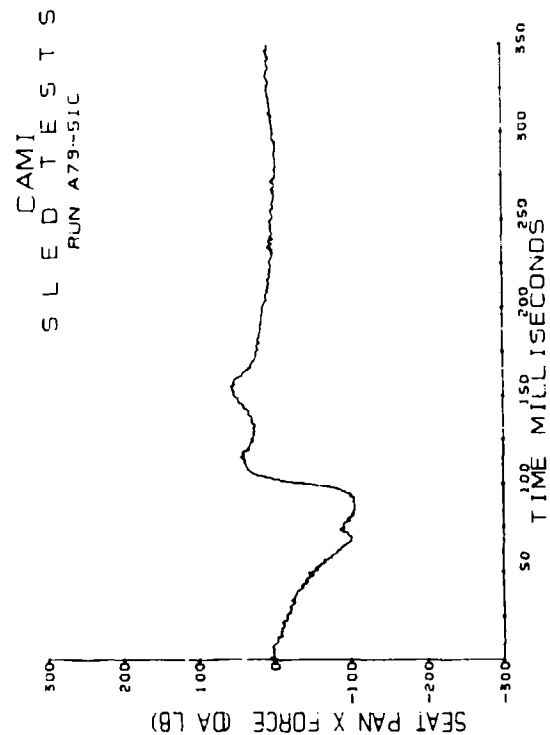


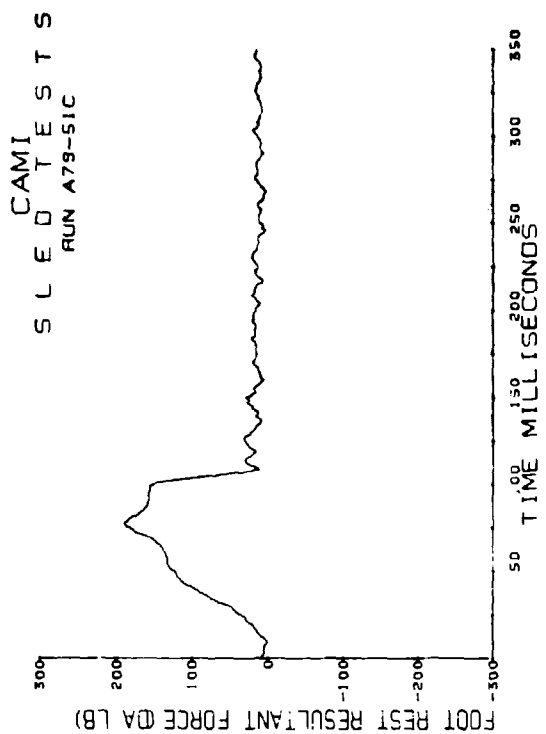
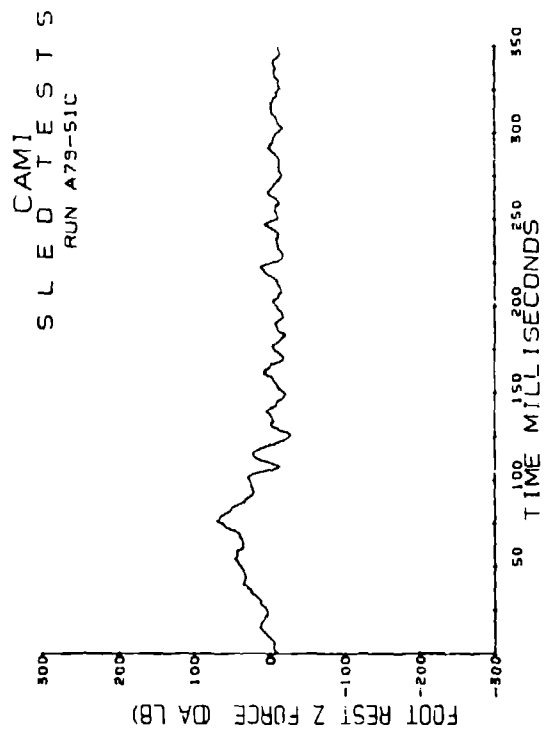
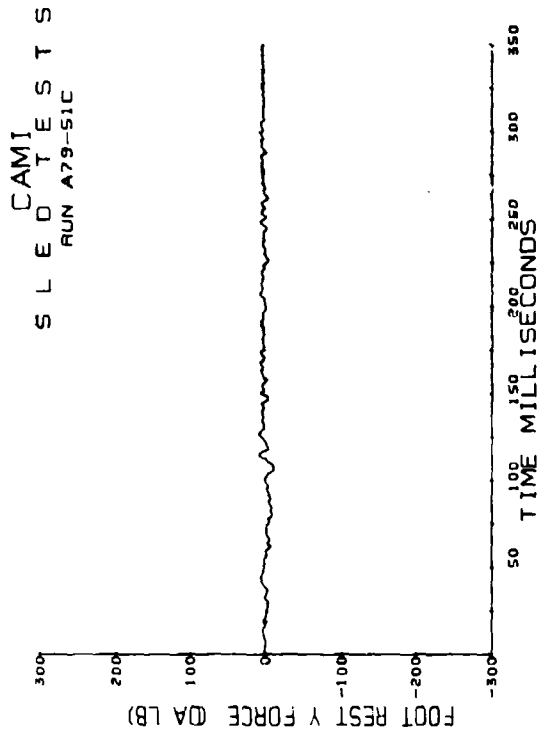
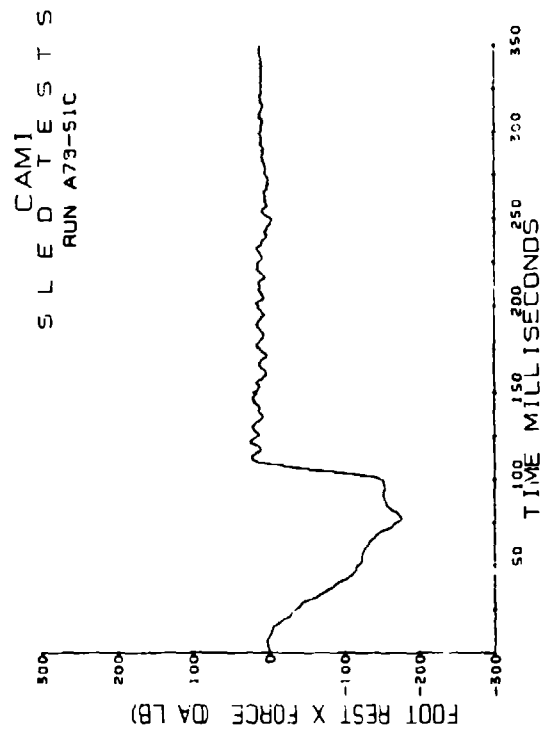
CAMI
S L E D T E S T S
RUN A79-51B



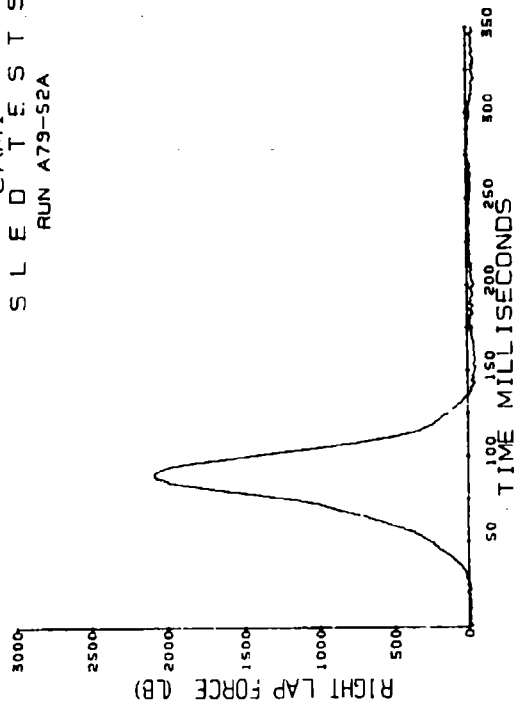
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S L E D T E S T S
RUN A79-51B



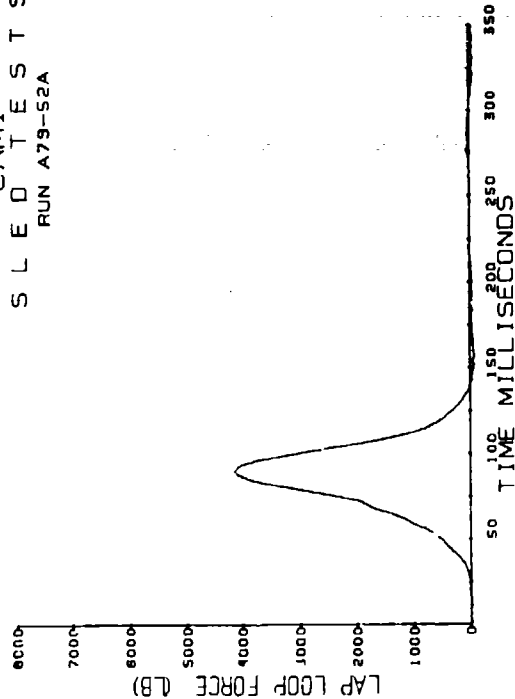




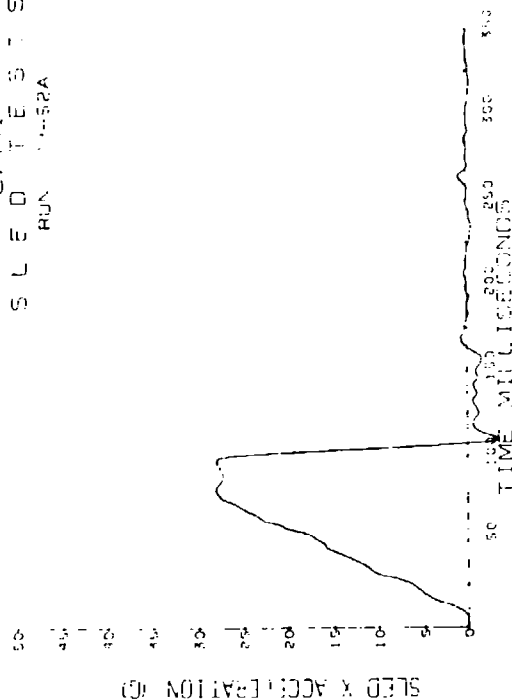
CAMI
SLED TESTS
RUN A79-S2A



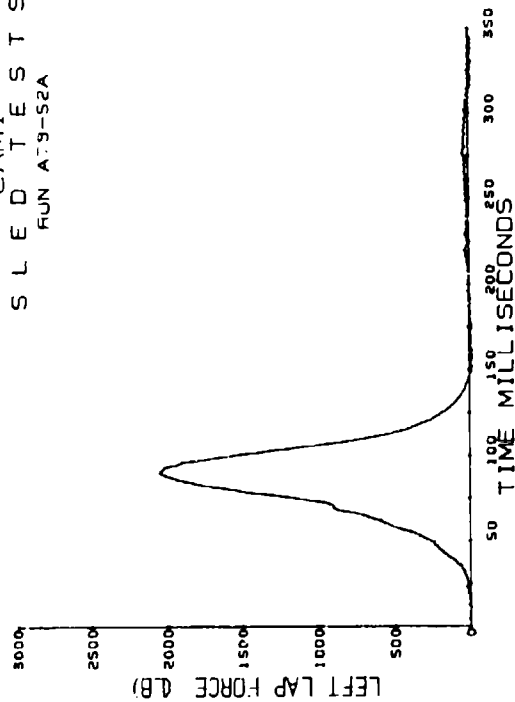
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SLED TESTS
RUN A79-S2A



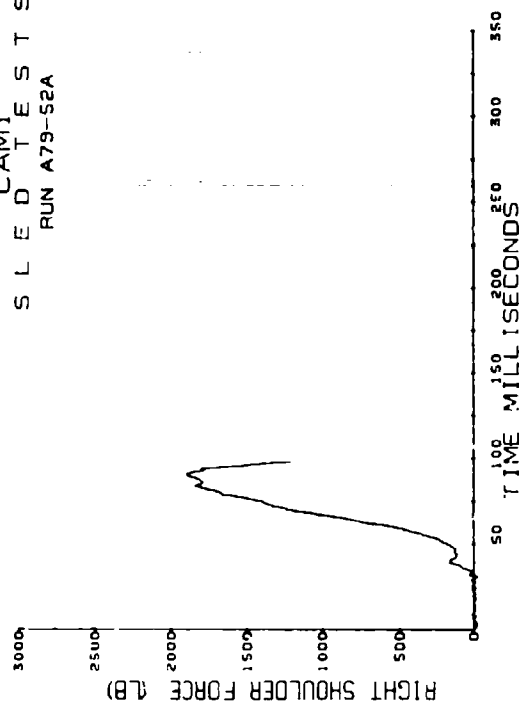
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SLED TESTS
RUN A79-S2A



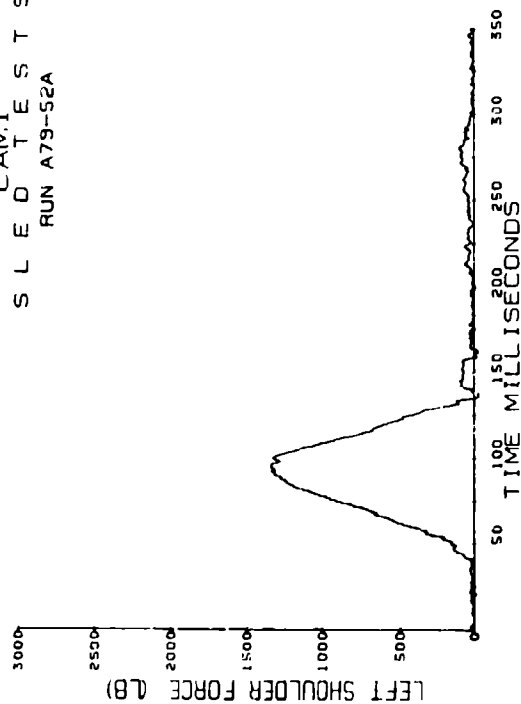
CAMI
SLED TESTS
RUN A79-S2A



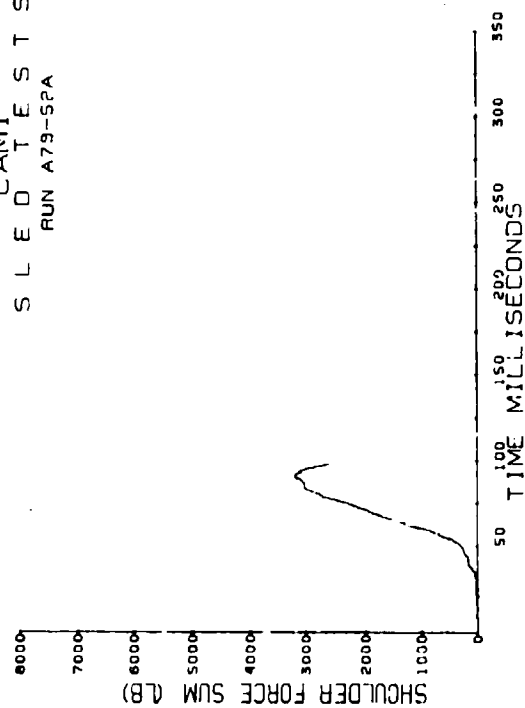
CAMI
S L E D T E S T S
RUN A79-52A

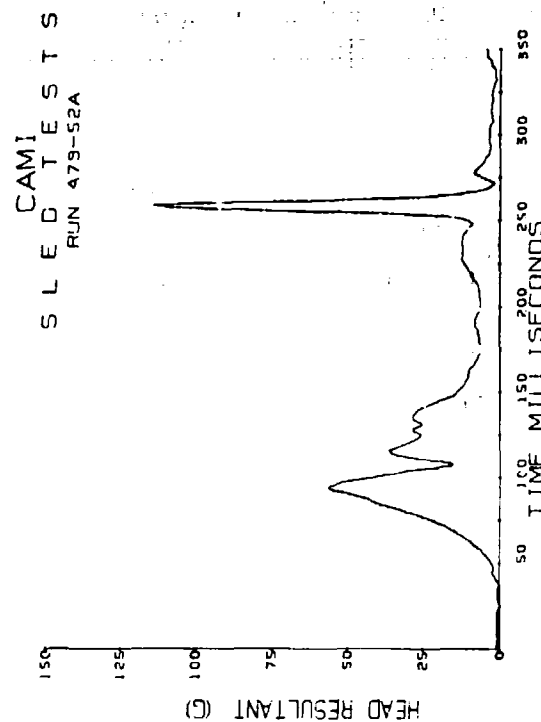
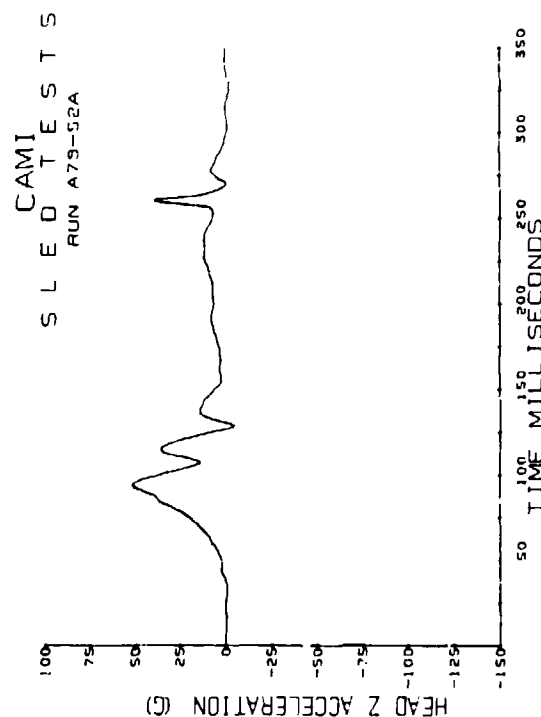
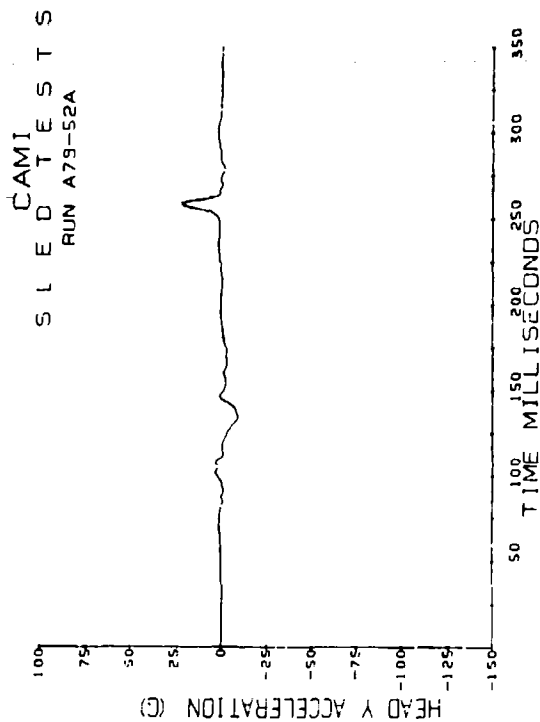
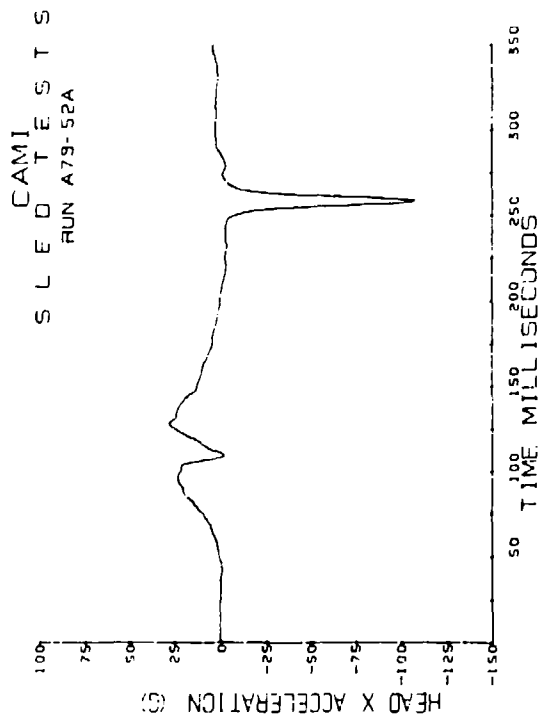


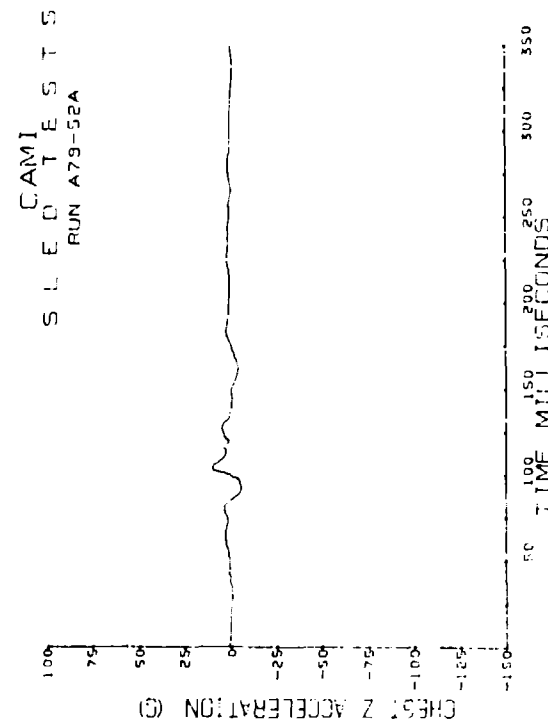
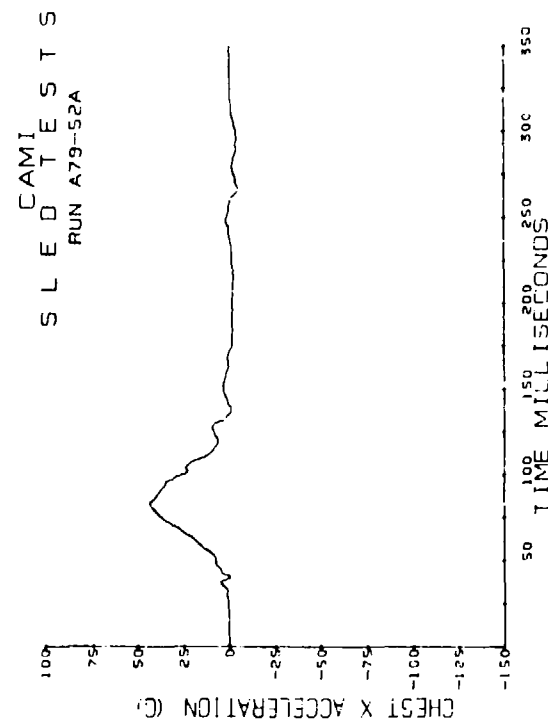
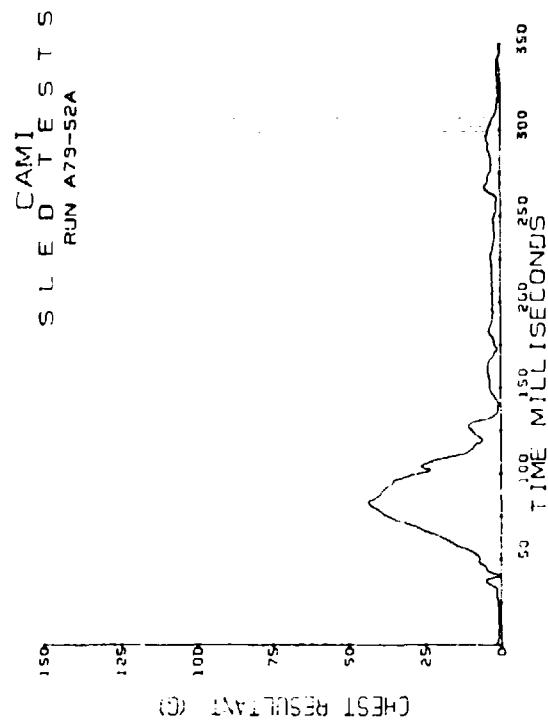
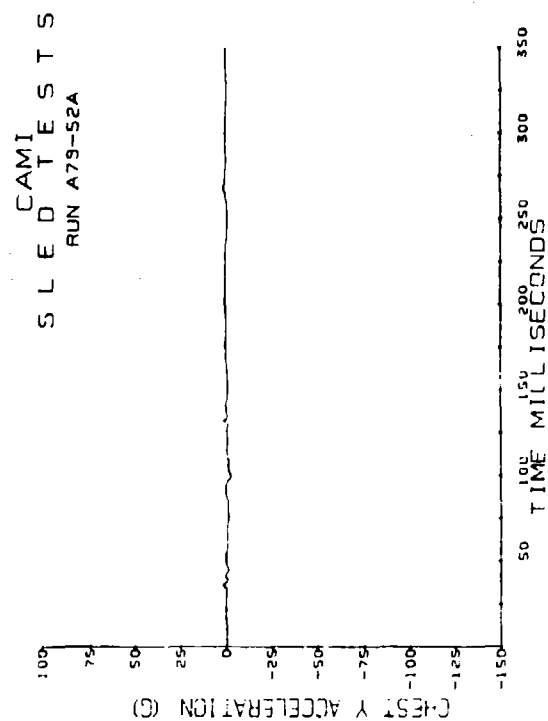
CAMI
S L E D T E S T S
RUN A79-52A

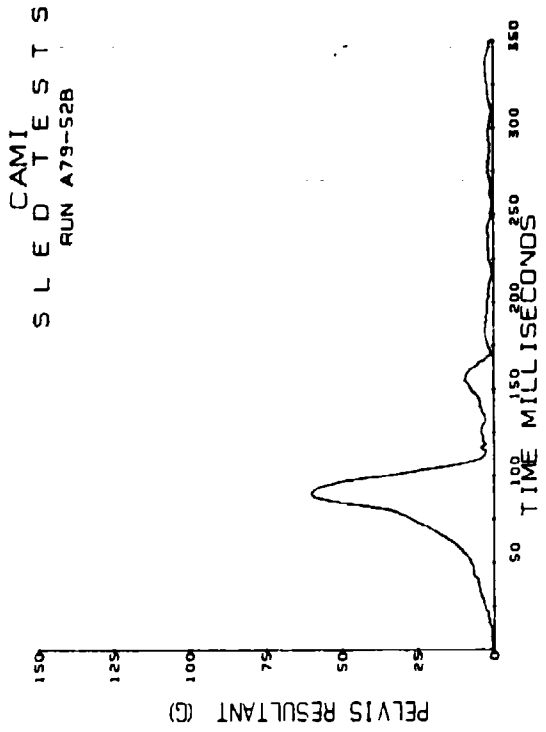
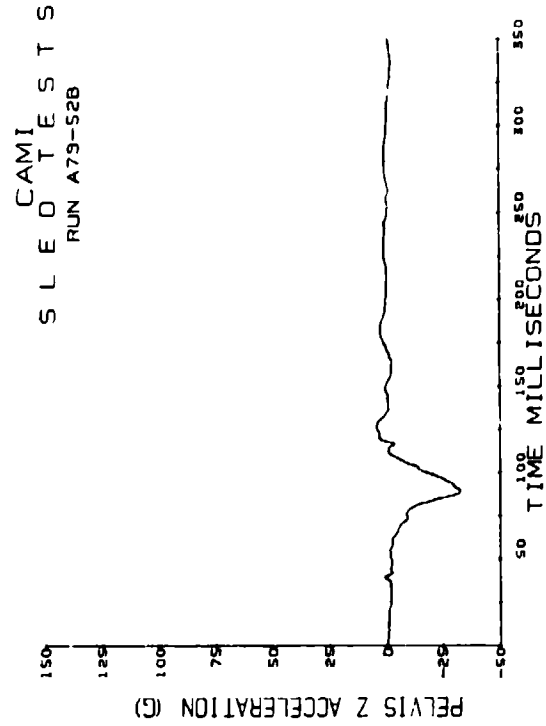
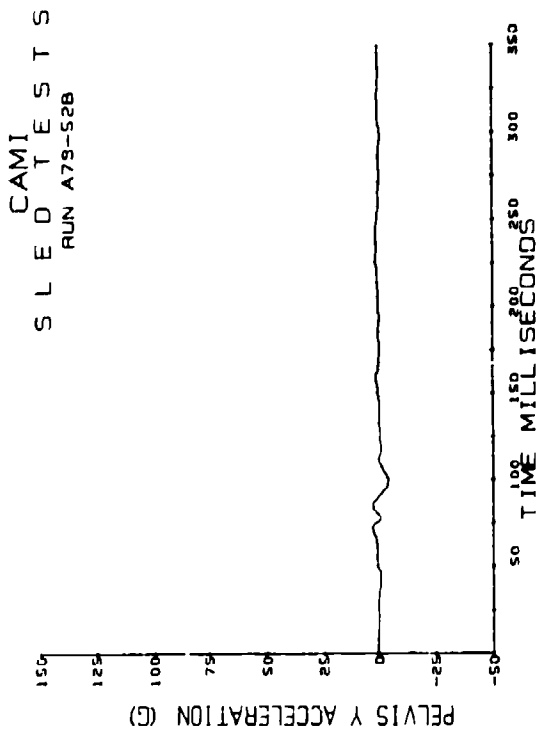
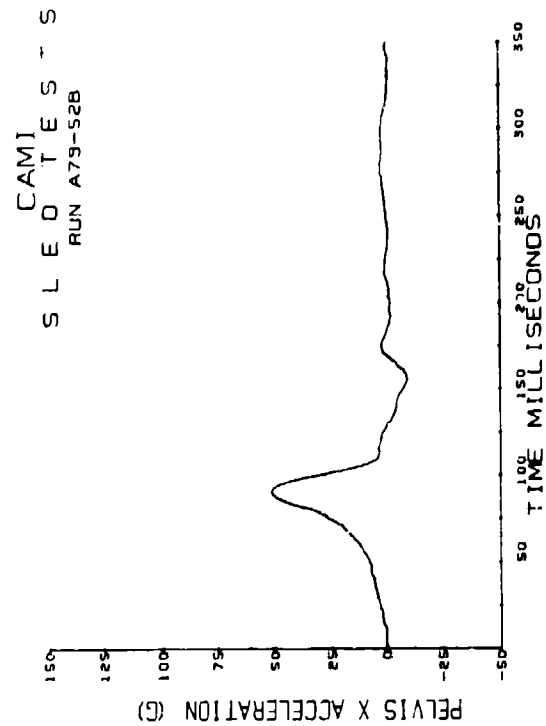


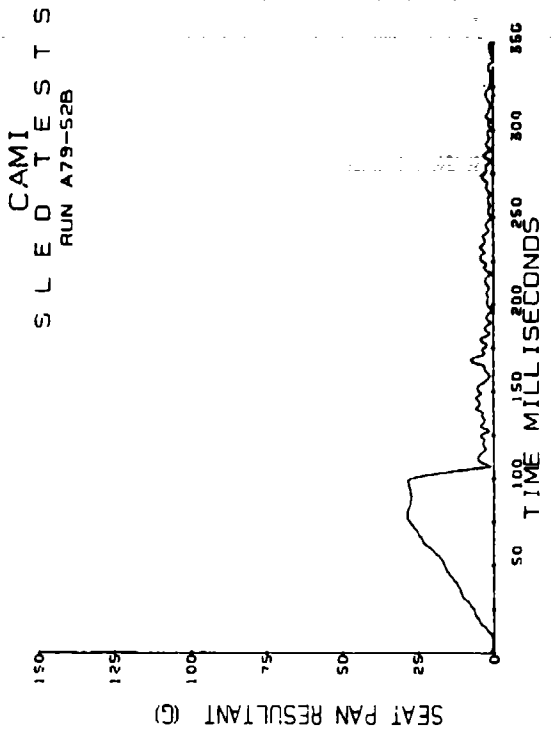
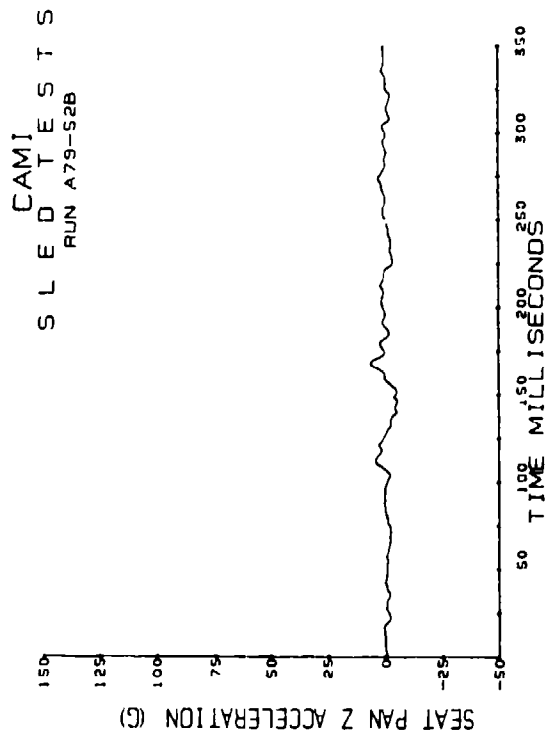
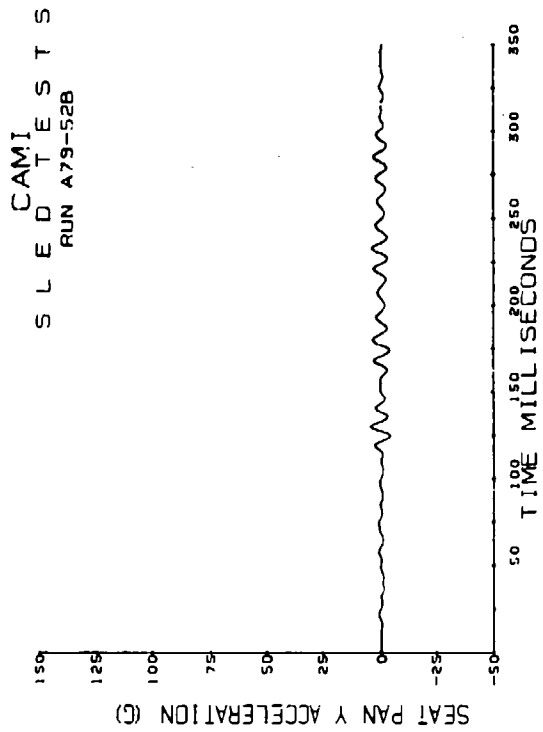
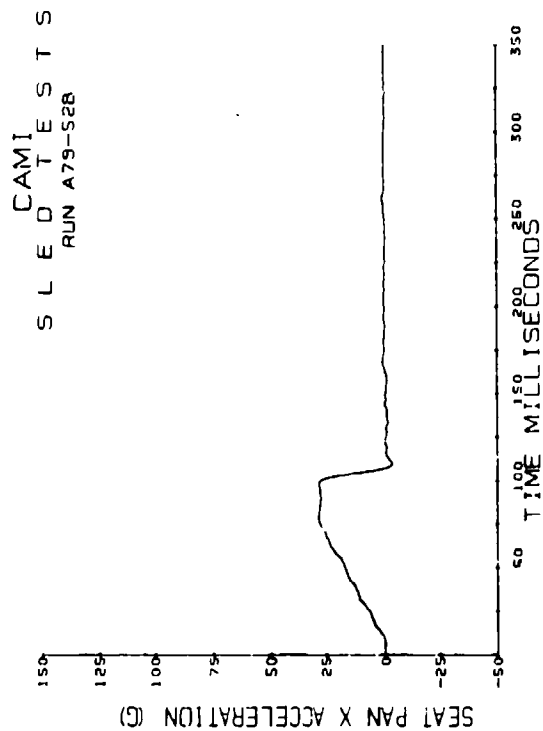
CAMI
S L E D T E S T S
RUN A79-52A



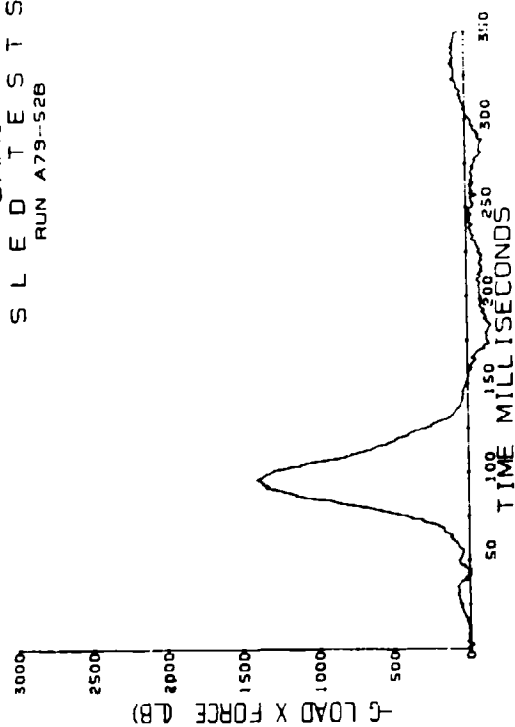




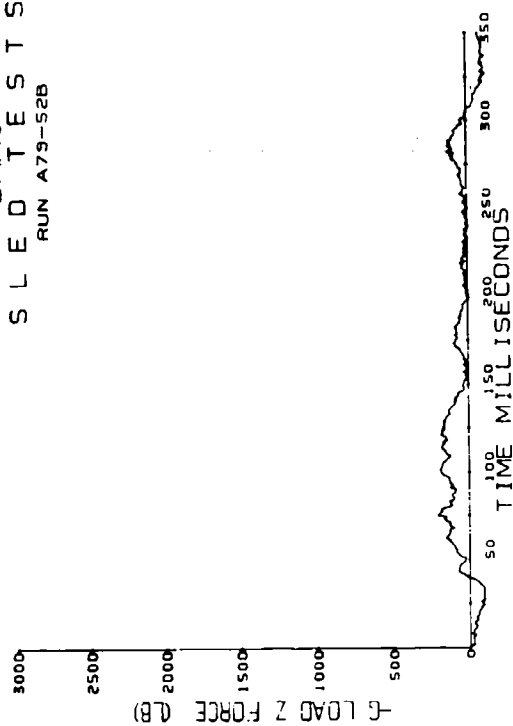


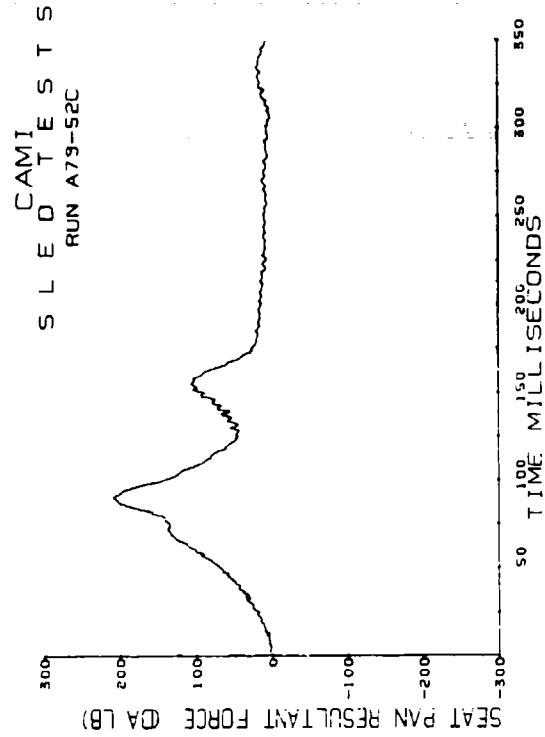
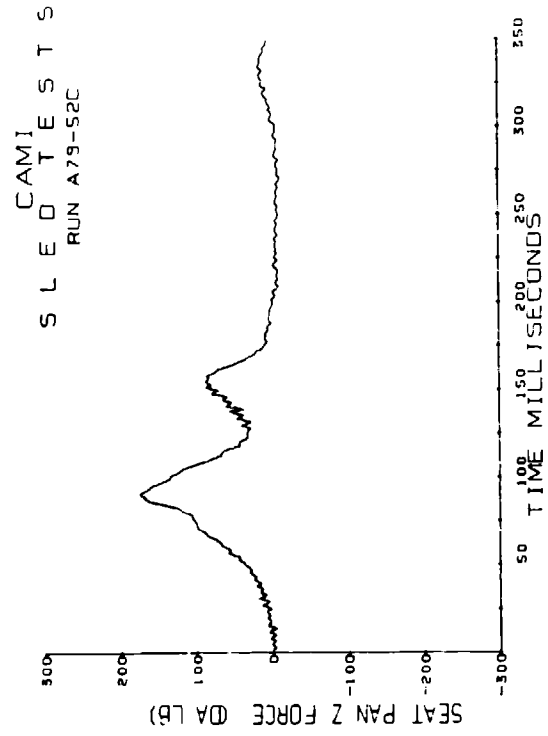
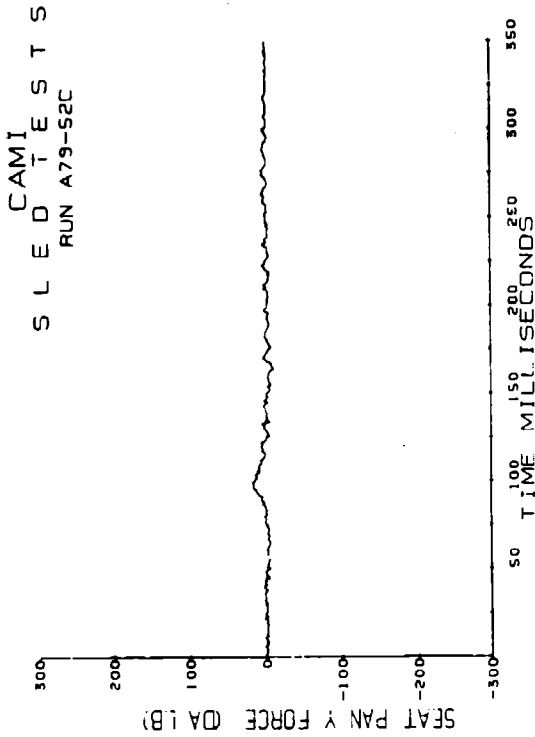
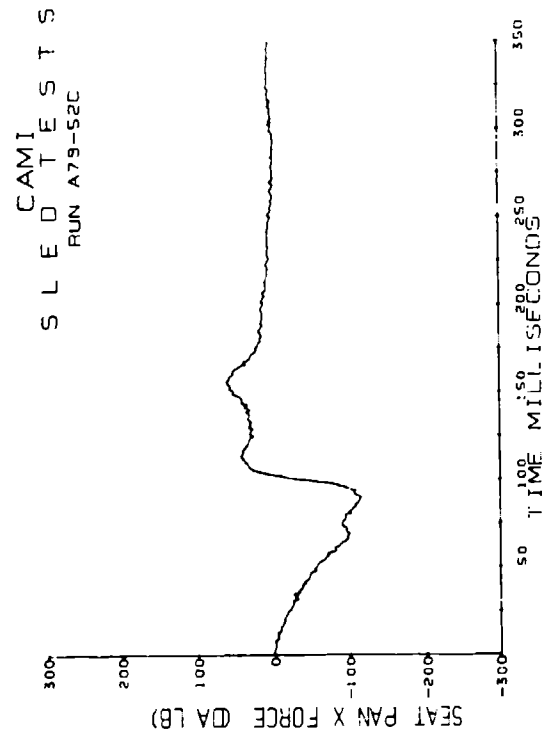


CAMI
S L E D T E S T S
RUN A79-52B

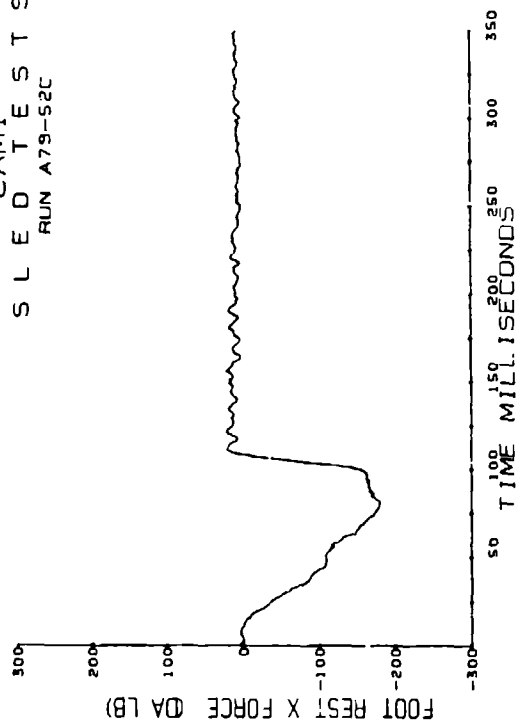


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S L E D T E S T S
RUN A79-52B

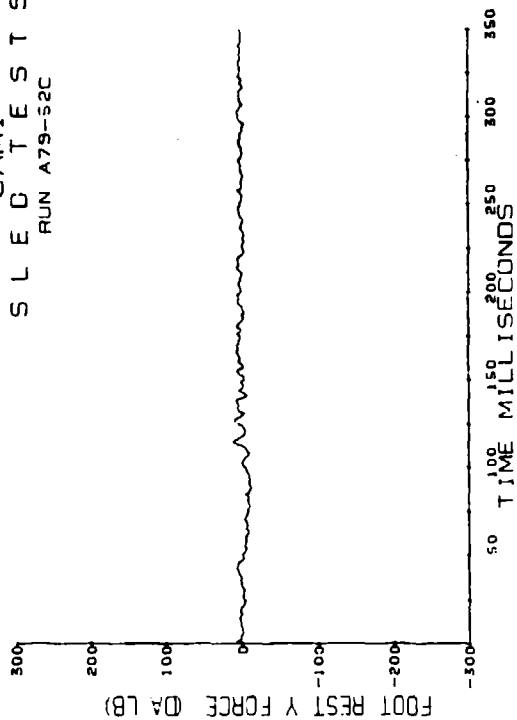




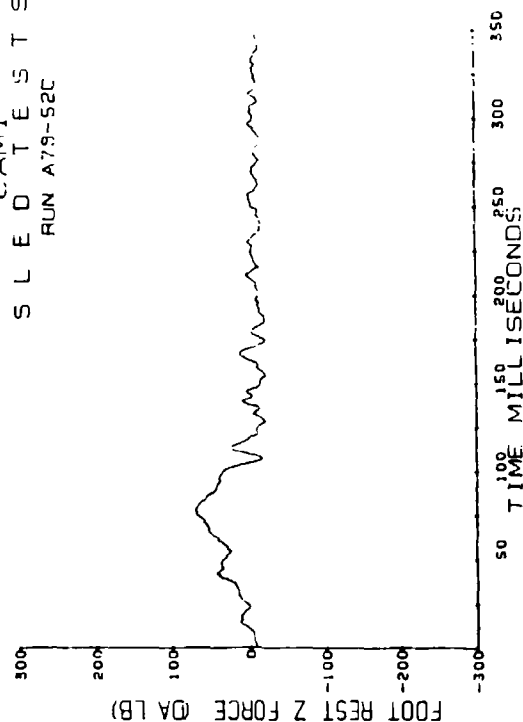
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S L E D T E S T S
RUN A79-52C



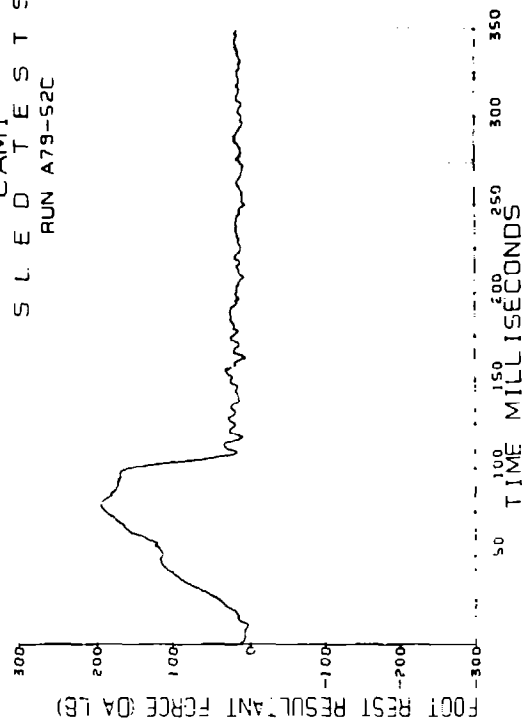
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S L E D T E S T S
RUN A79-52C

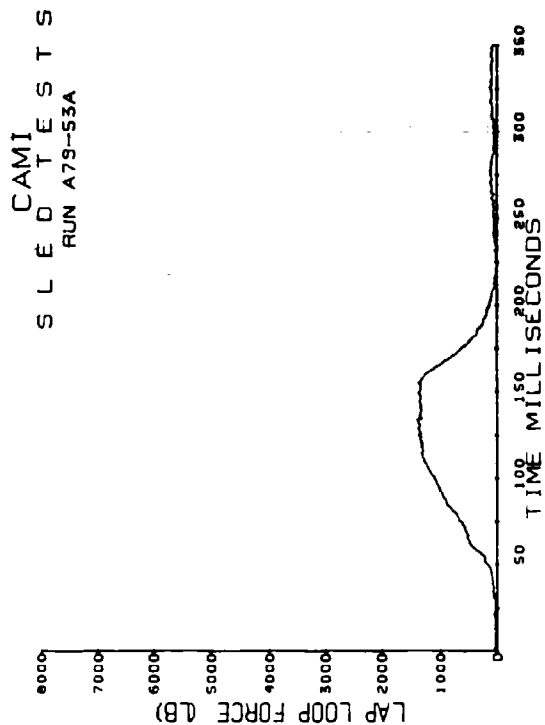
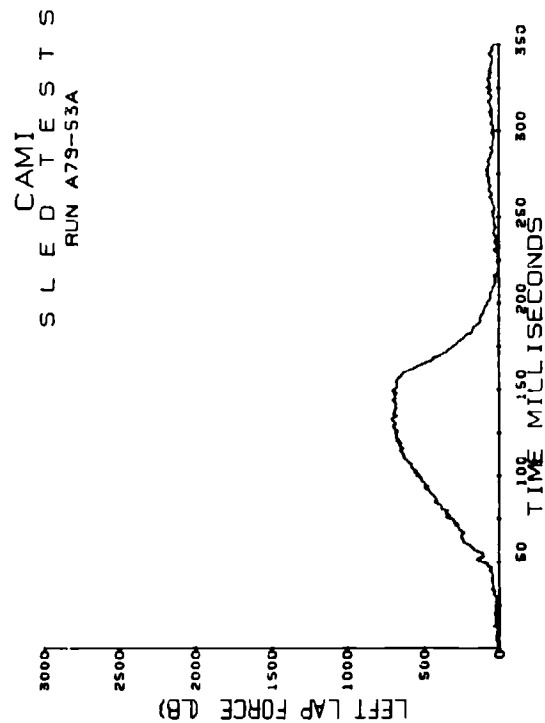
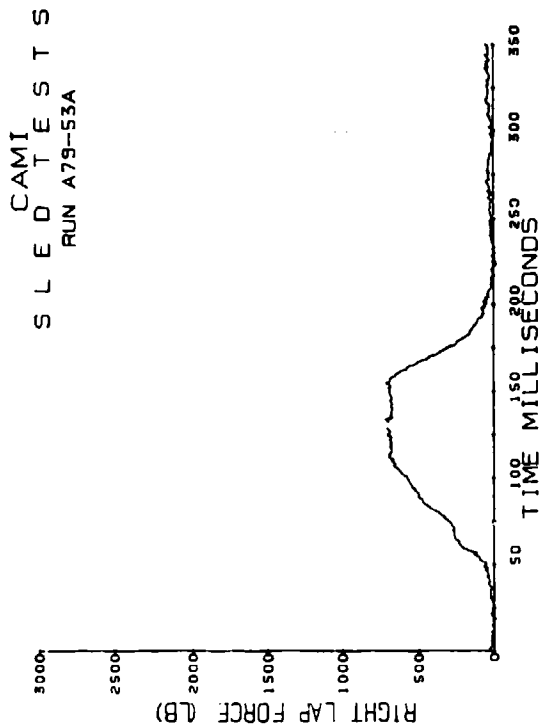
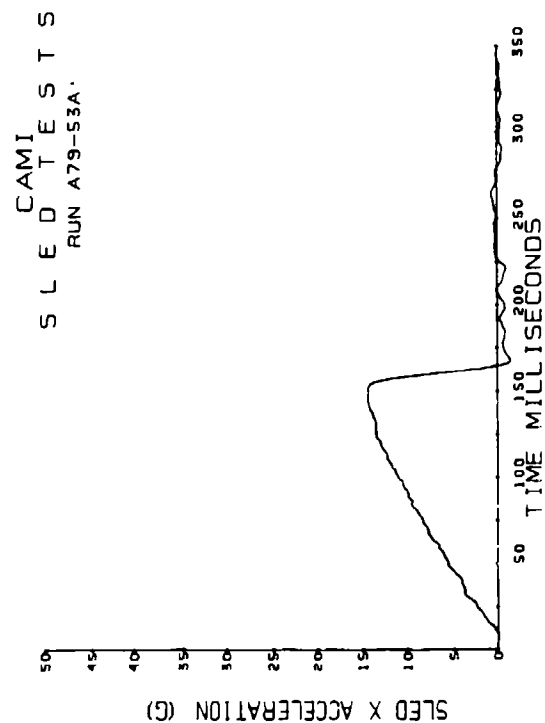


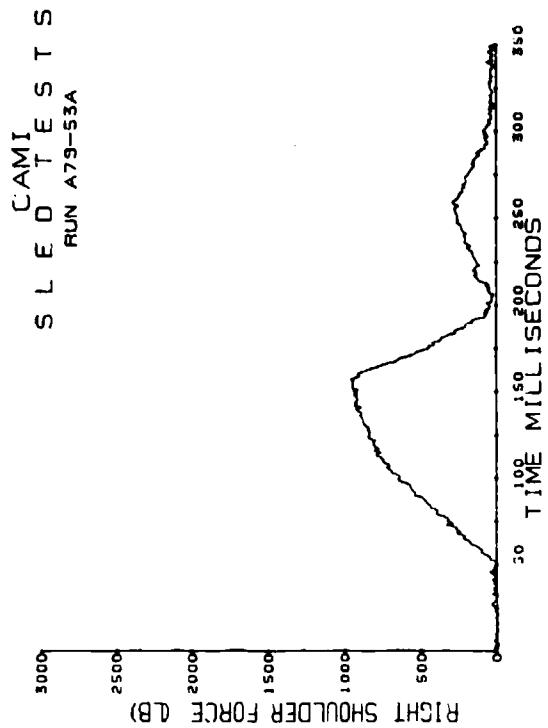
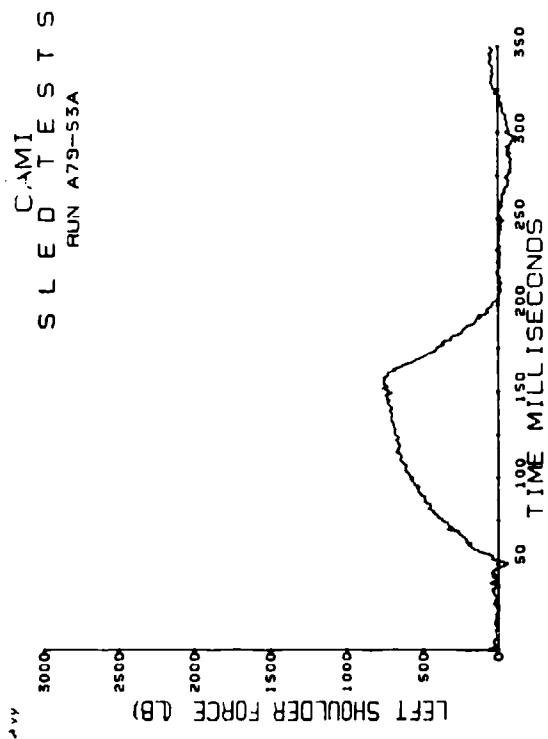
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S L E D T E S T S
RUN A79-52C



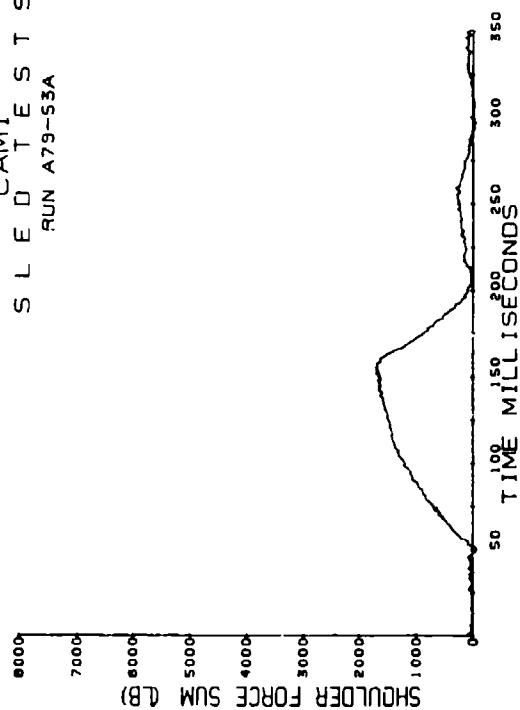
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S L E D T E S T S
RUN A79-52C

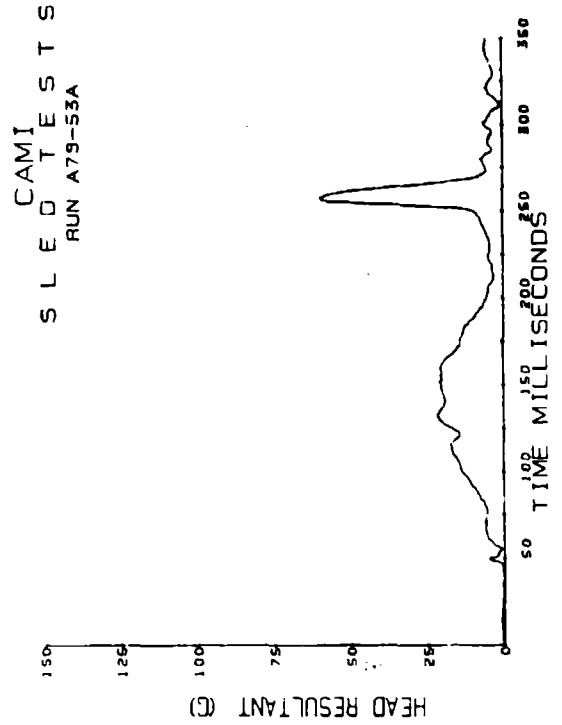
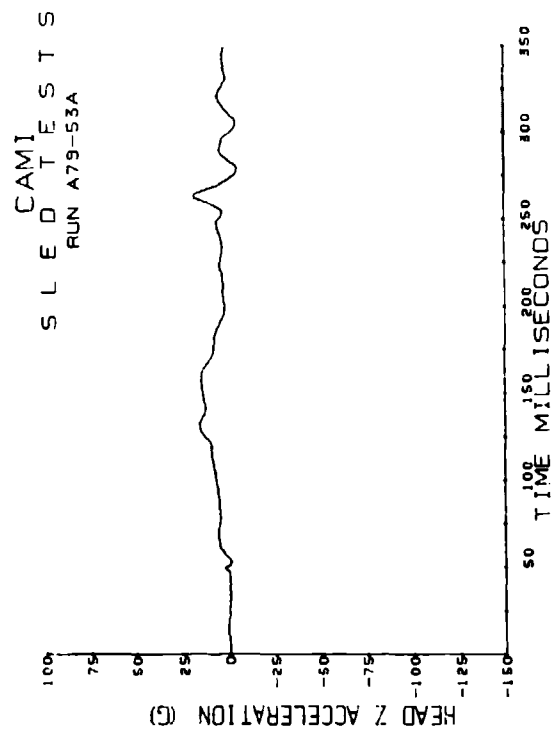
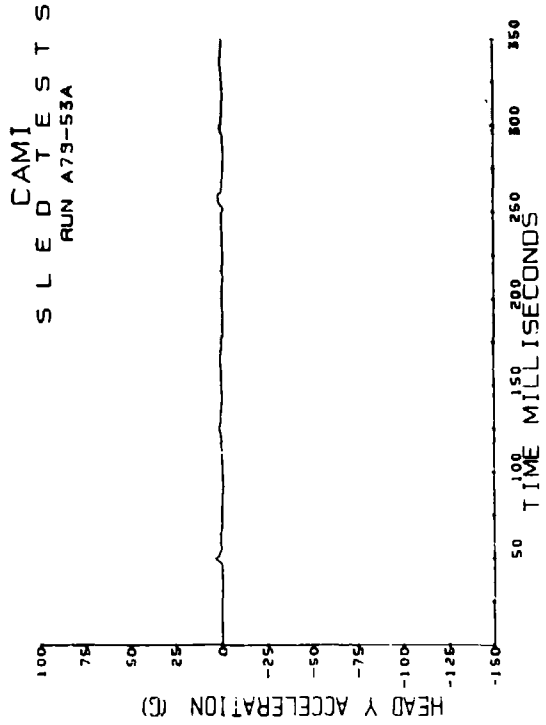
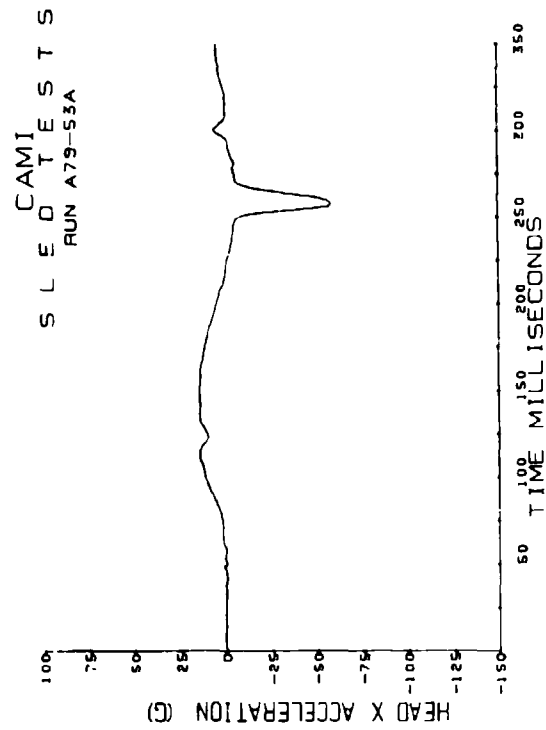


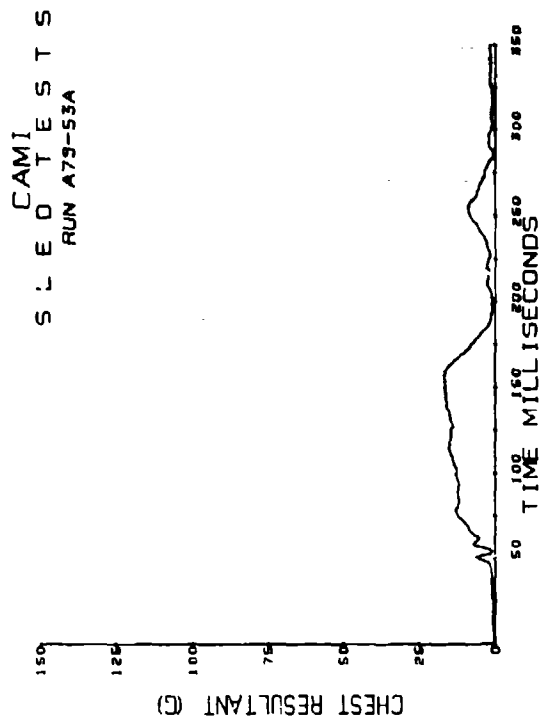
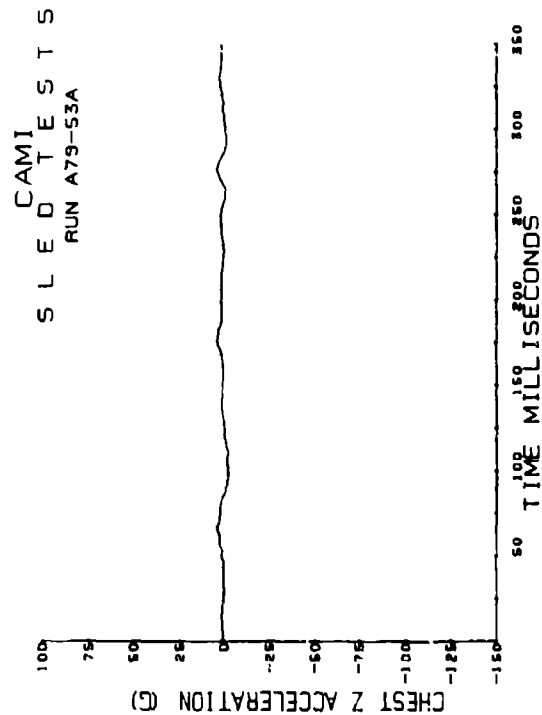
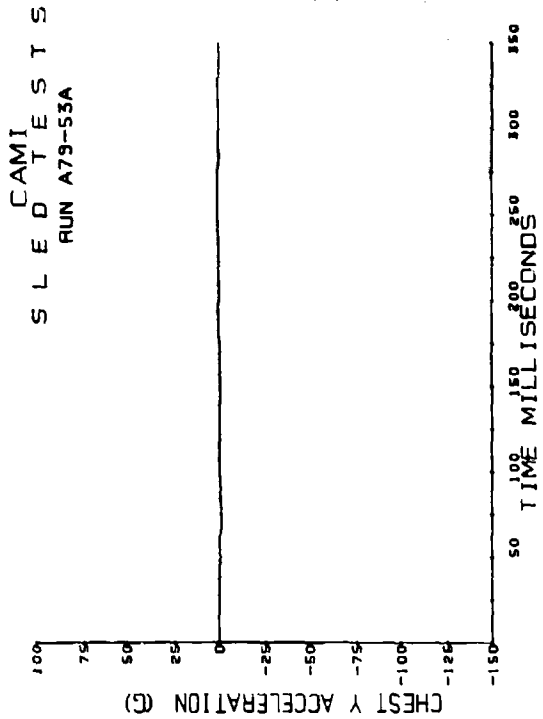
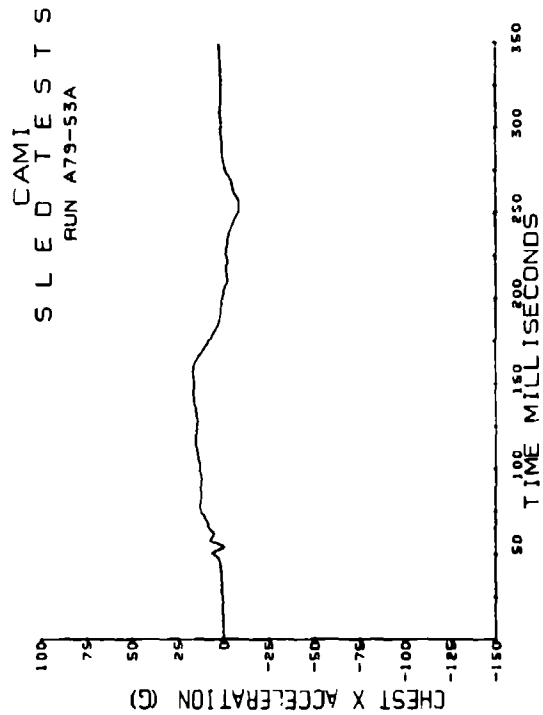


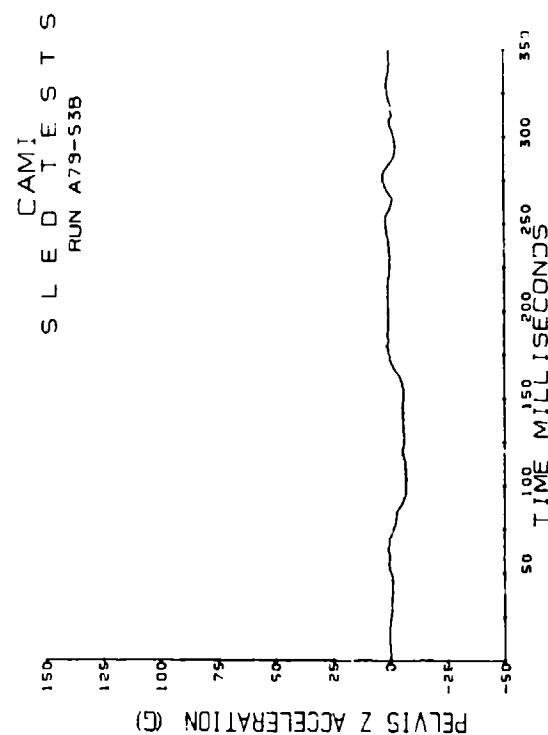
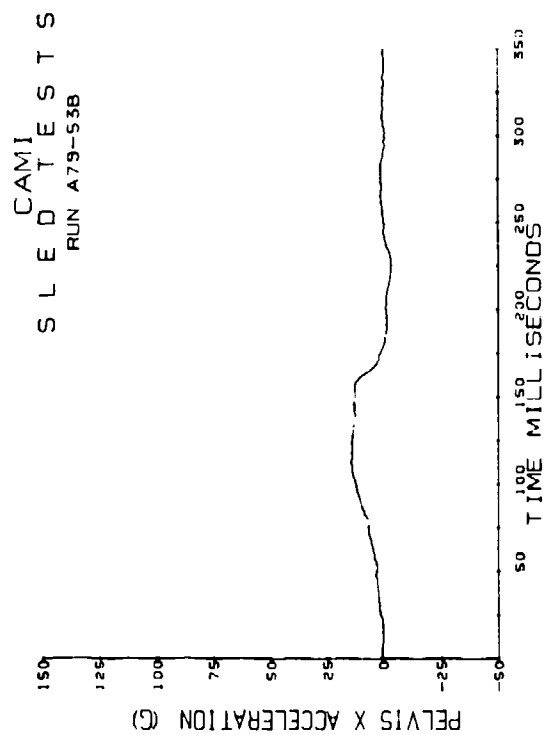
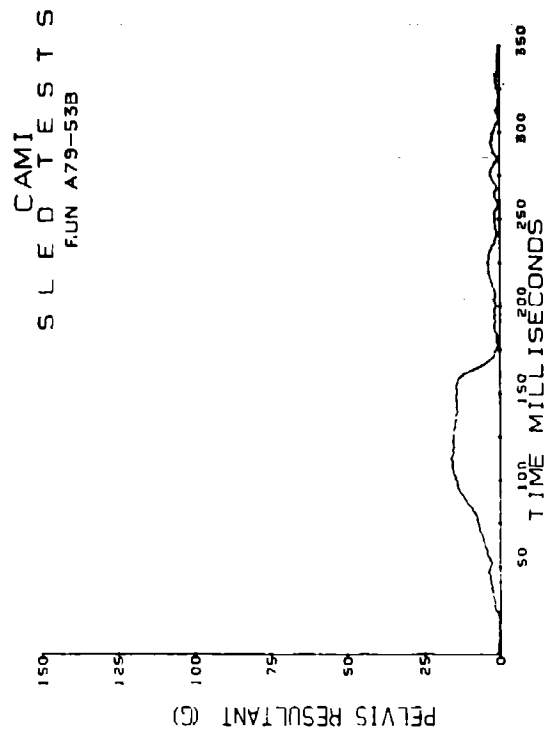
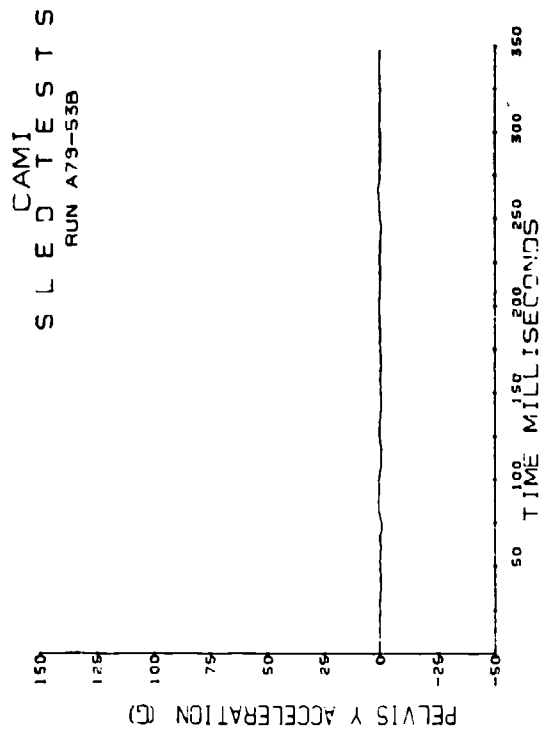


CAMI
S L E D T E S T S
RUN A79-53A

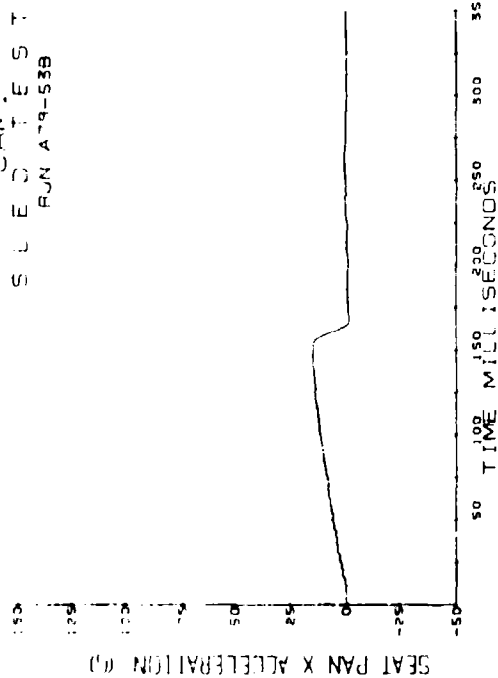




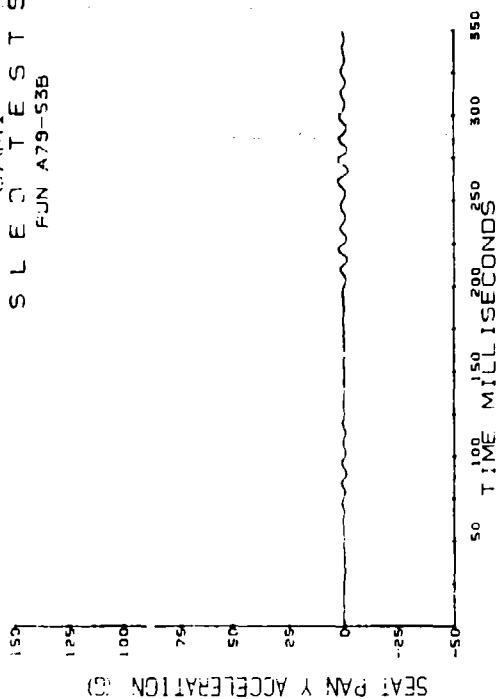




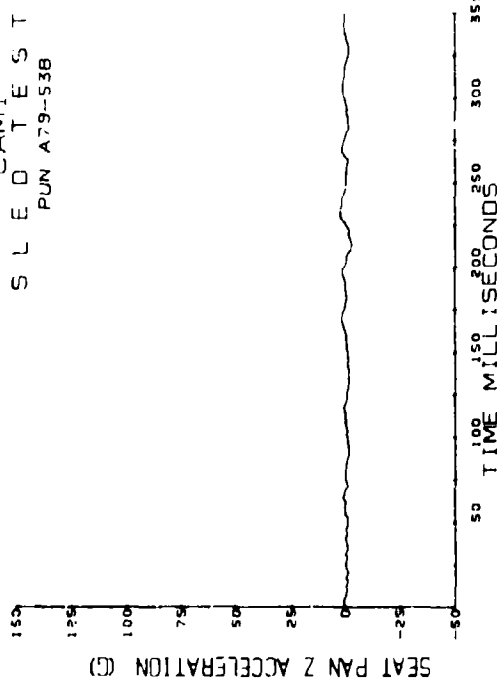
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S L E D T E S T S
RUN A79-53B



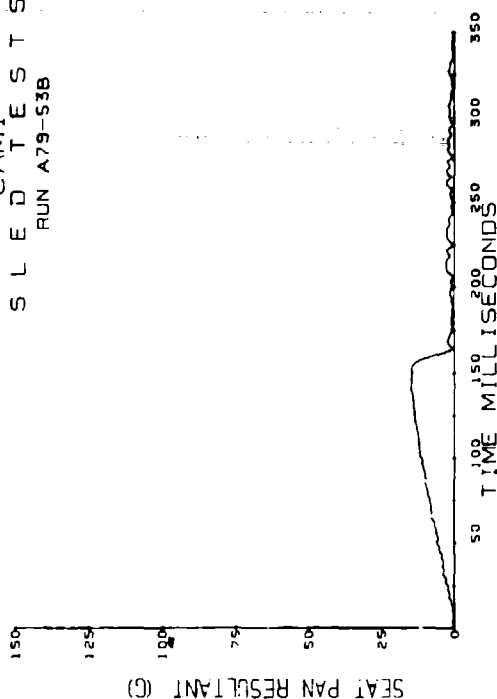
CAMI
S L E D T E S T S
RUN A79-53B

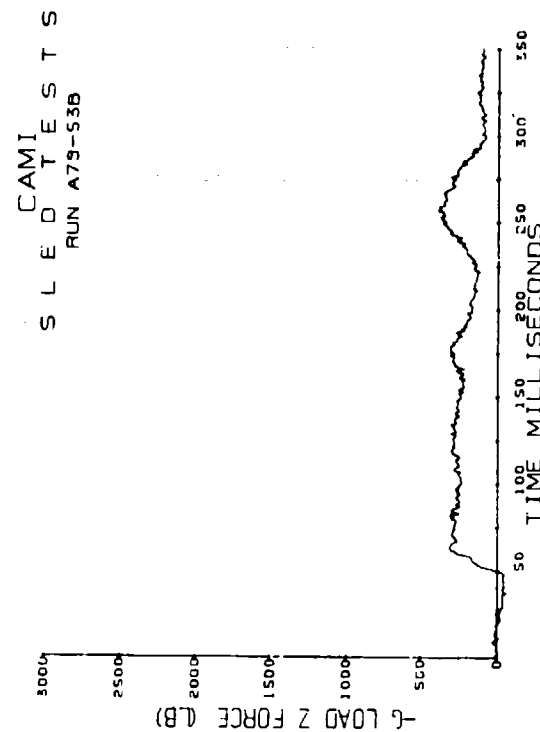
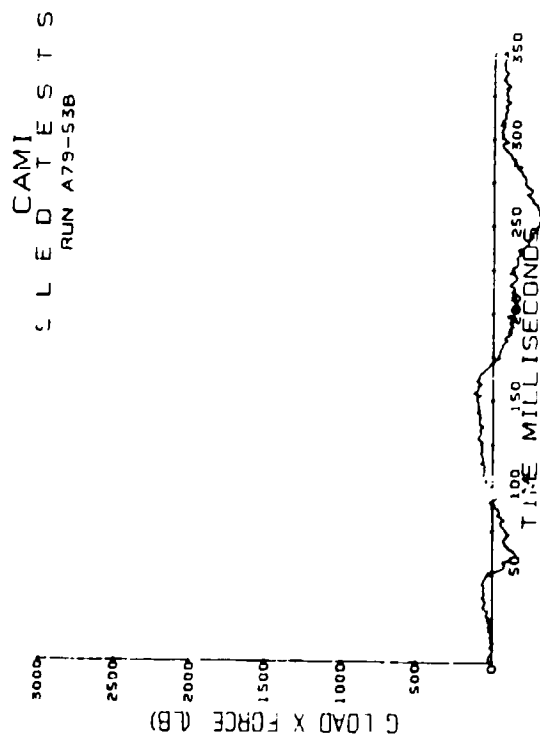


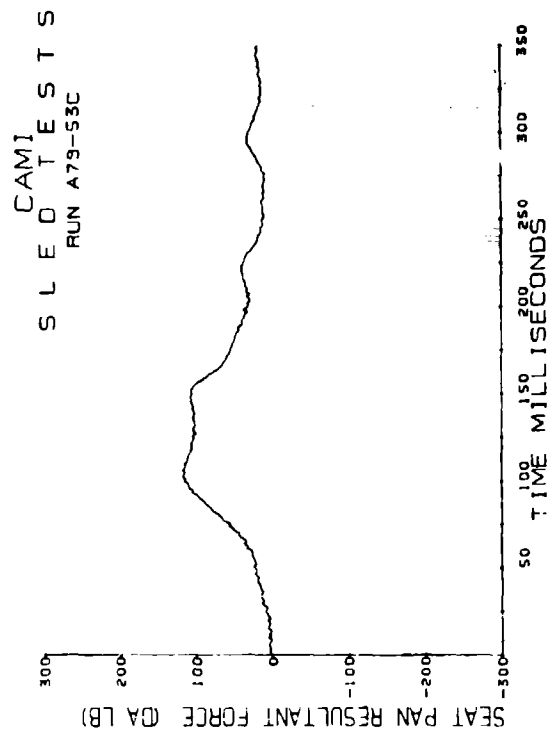
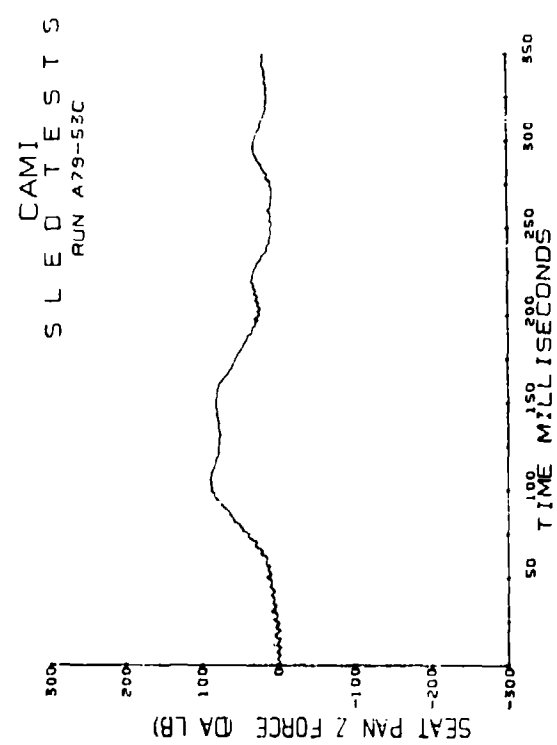
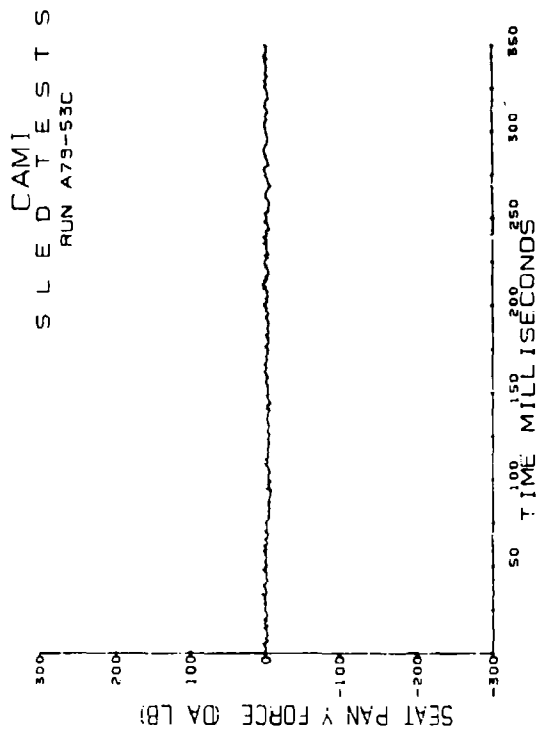
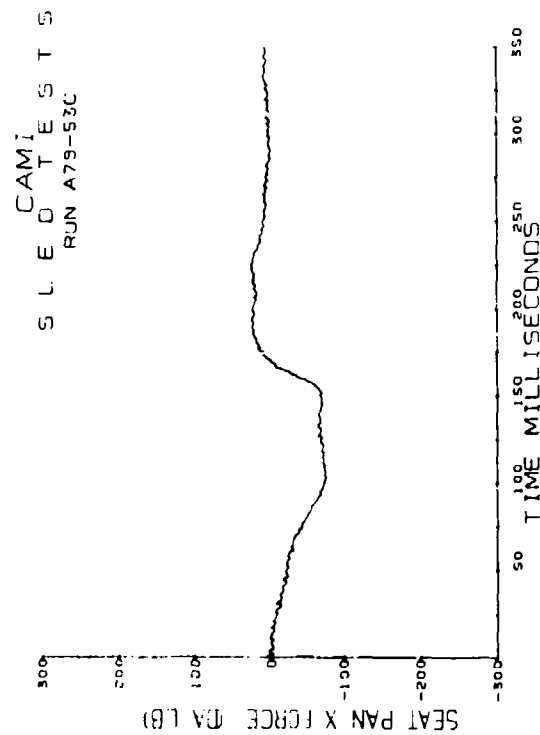
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S L E D T E S T S
RUN A79-53B

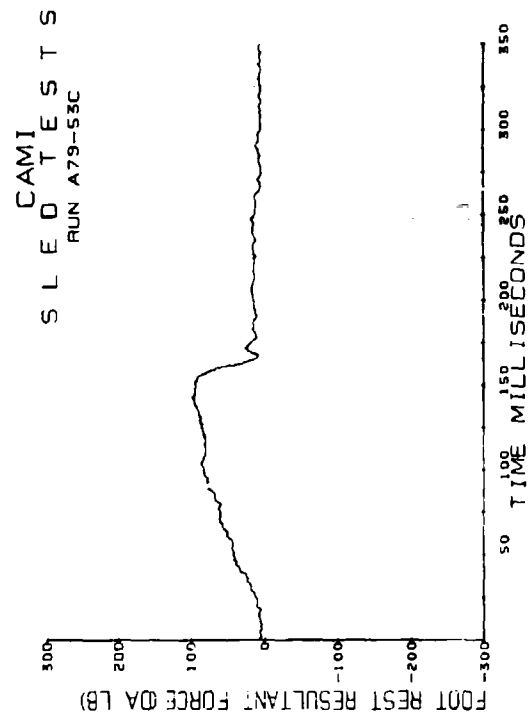
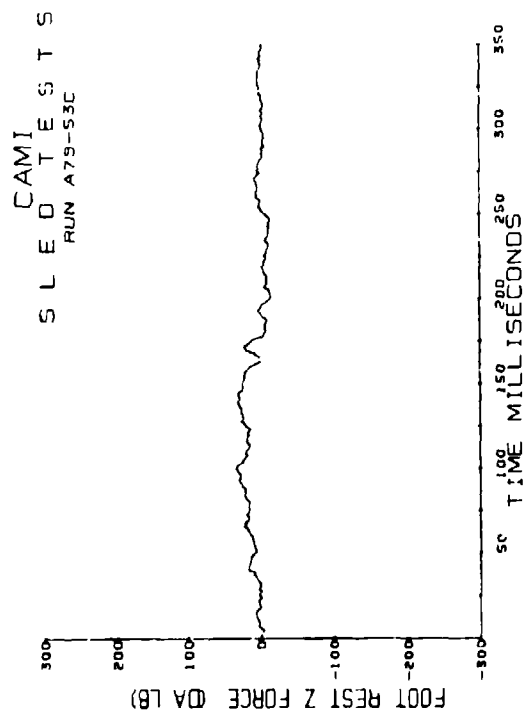
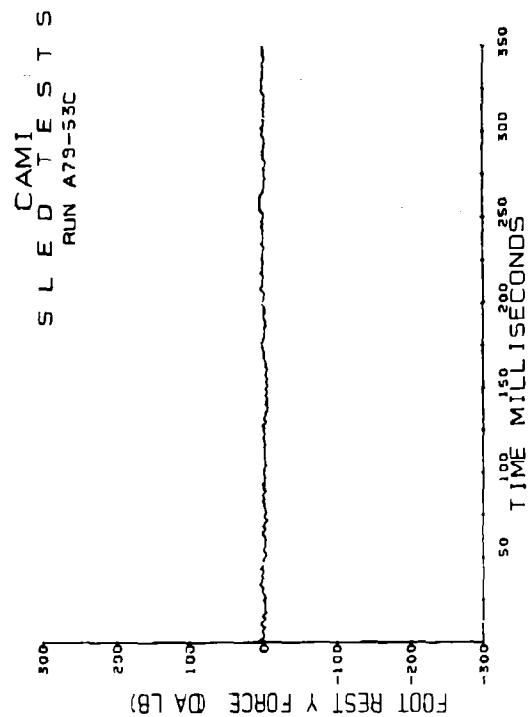
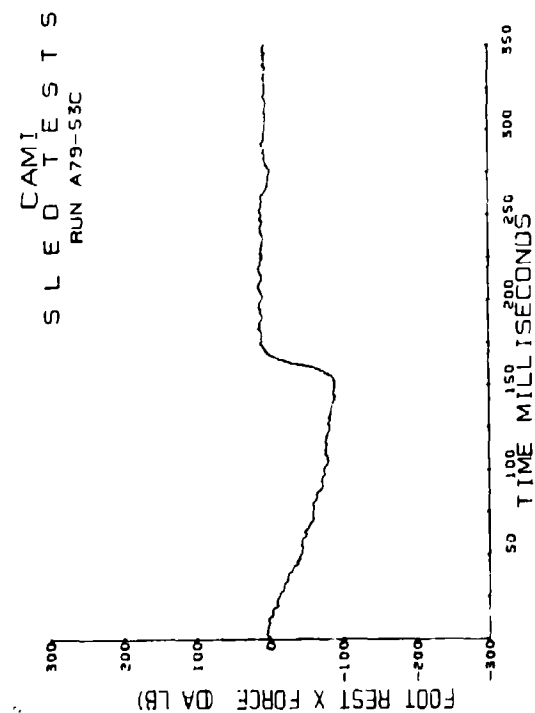


CAMI
S L E D T E S T S
RUN A79-53B

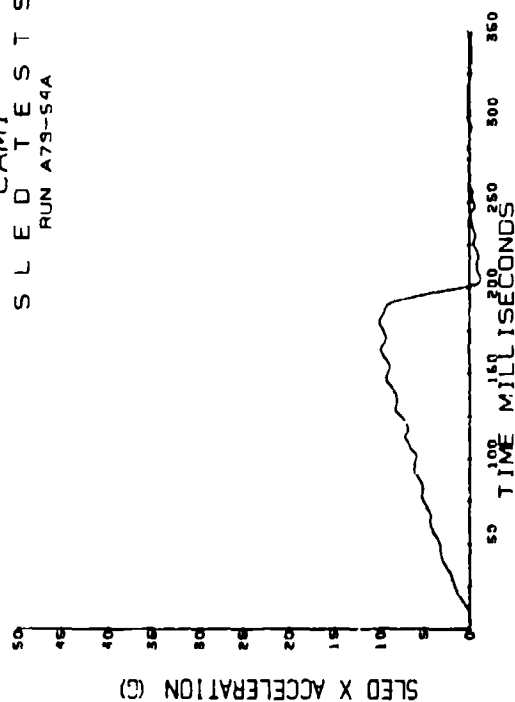




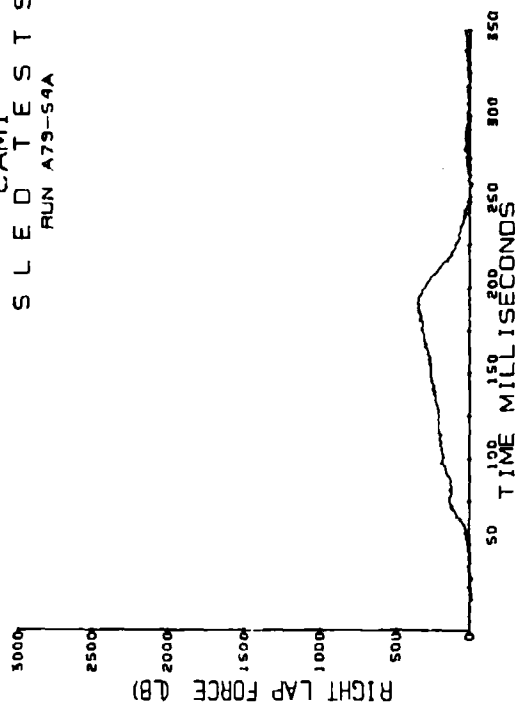




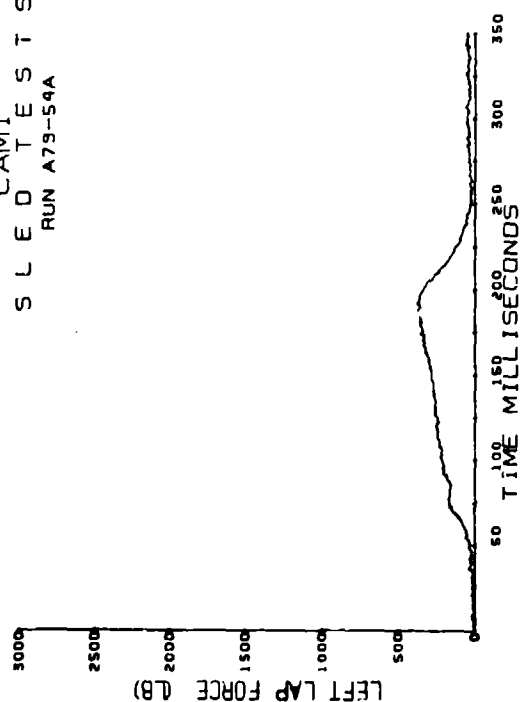
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S L E D T E S T S
RUN A79-54A



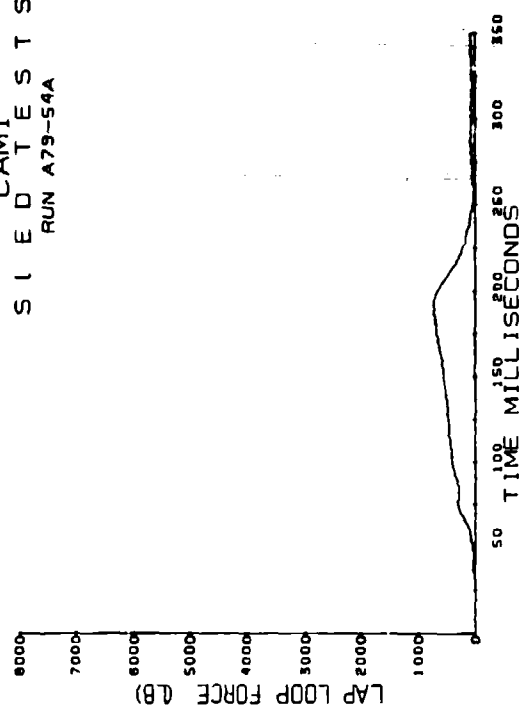
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S L E D T E S T S
RUN A79-54A



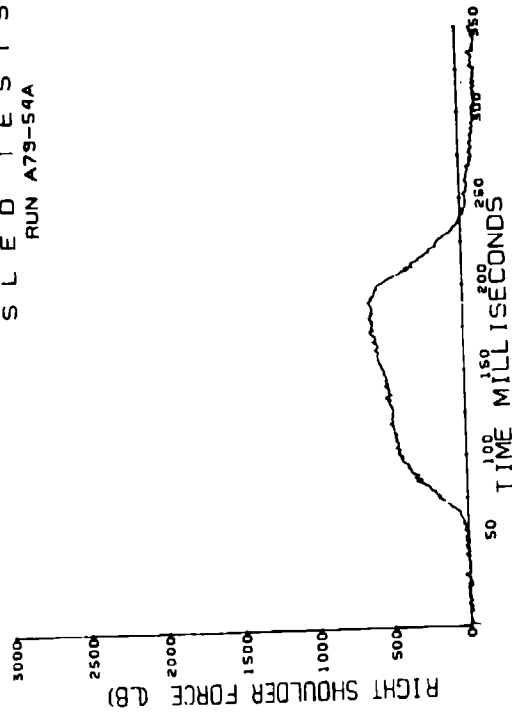
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S L E D T E S T S
RUN A79-54A



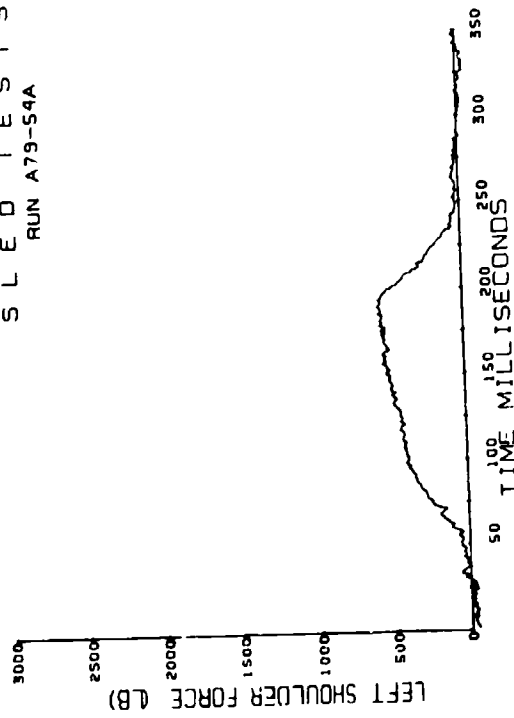
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S L E D T E S T S
RUN A79-54A



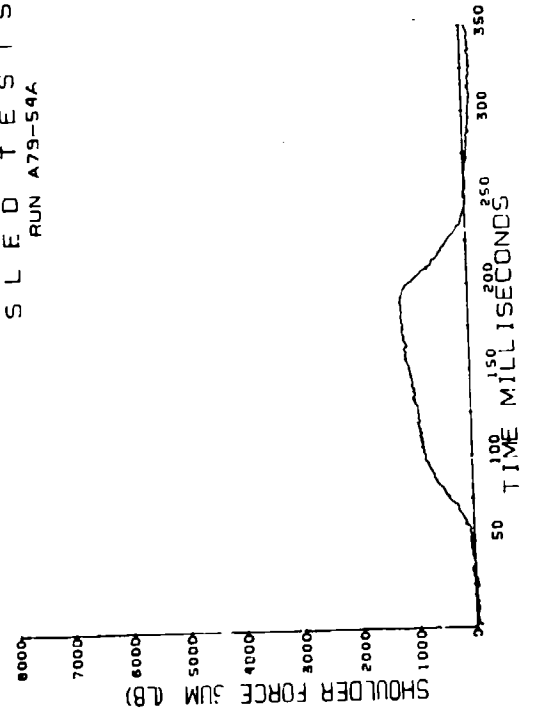
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RUN A79-54A



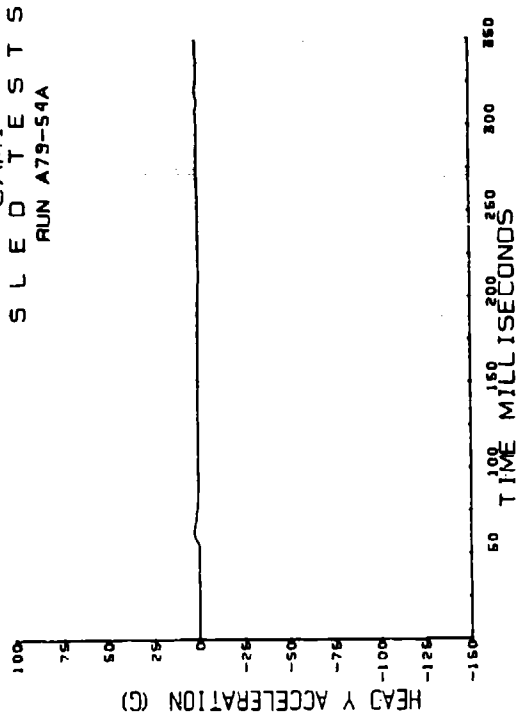
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S L E D T E S T S
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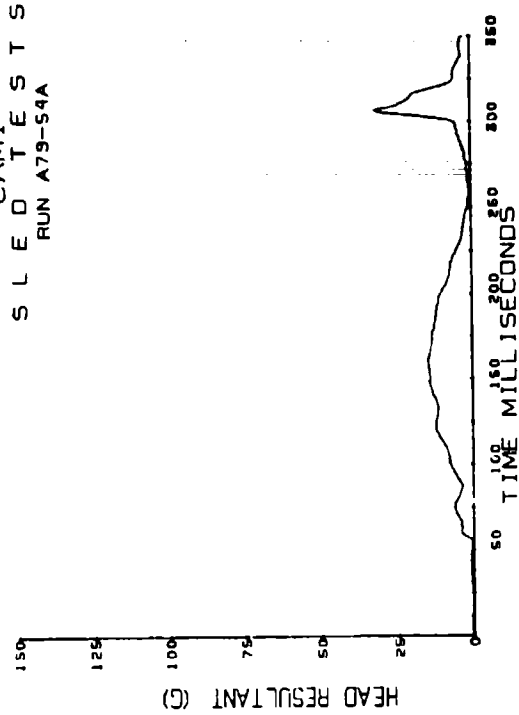
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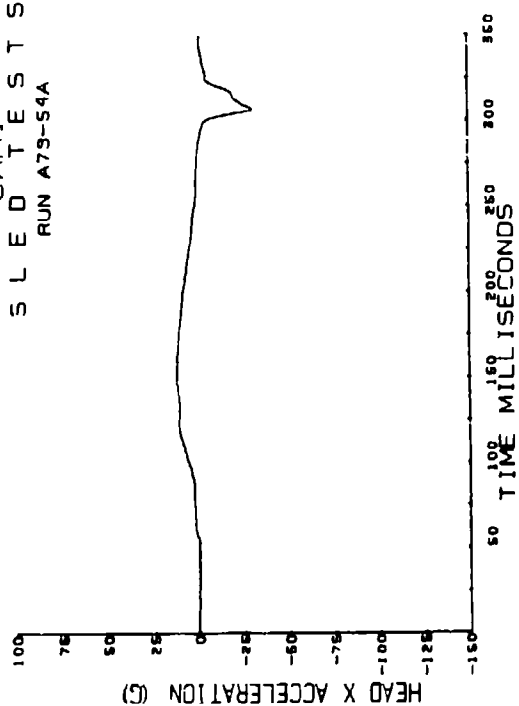
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S L E D T E S T S
RUN A79-S4A



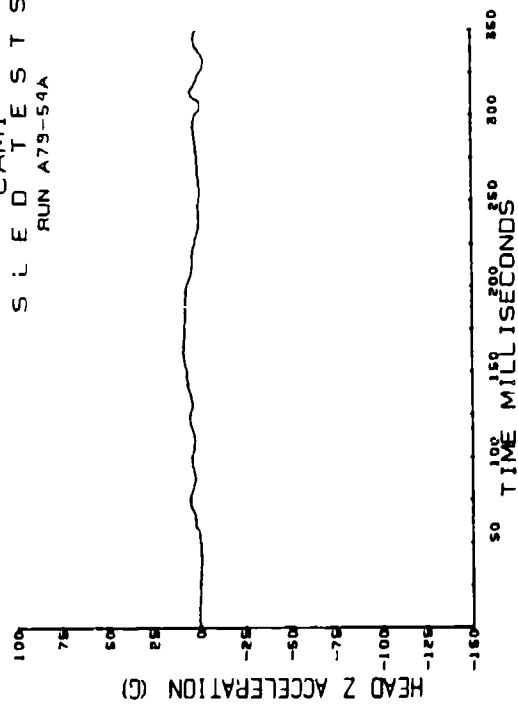
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RUN A79-S4A



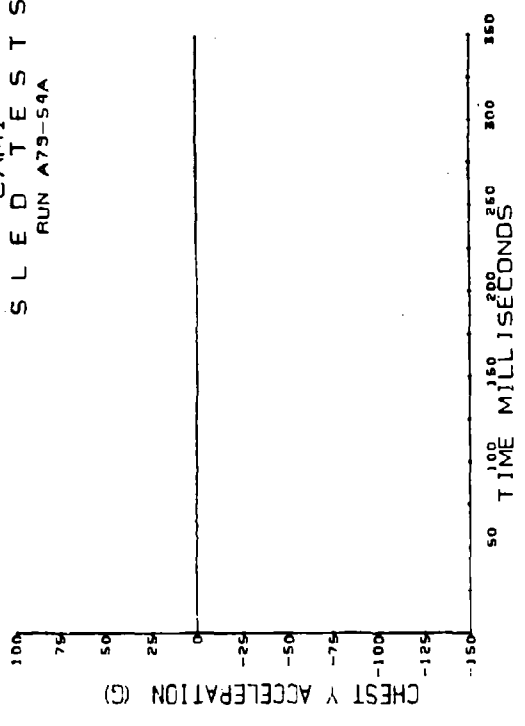
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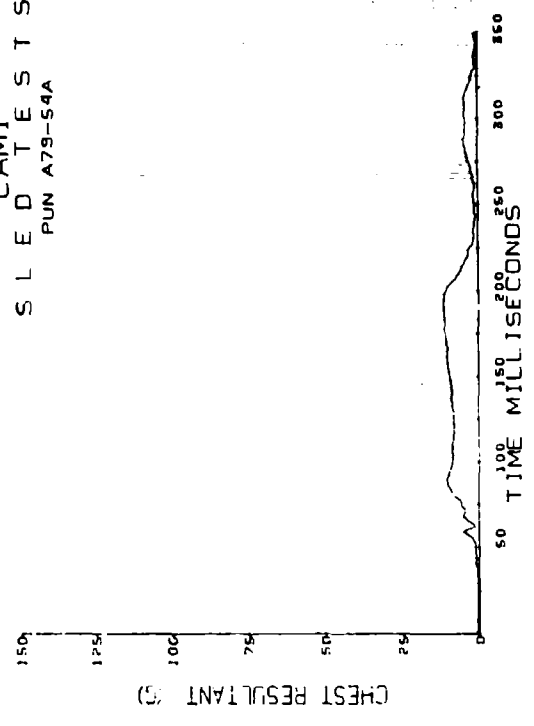
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RUN A79-S4A



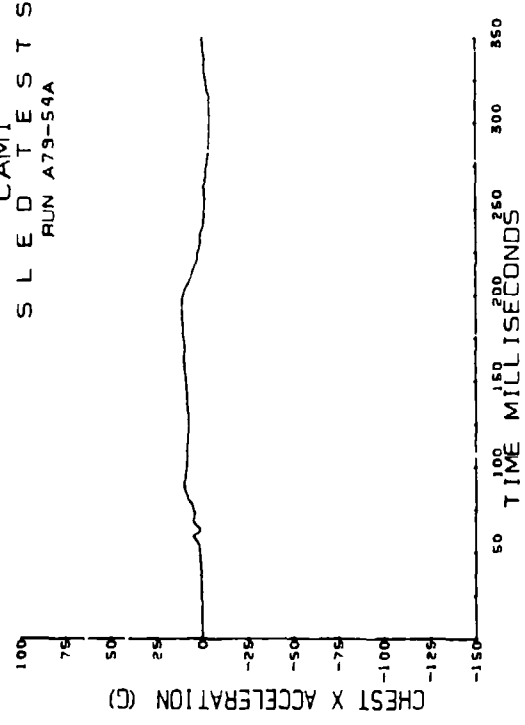
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RUN A79-54A



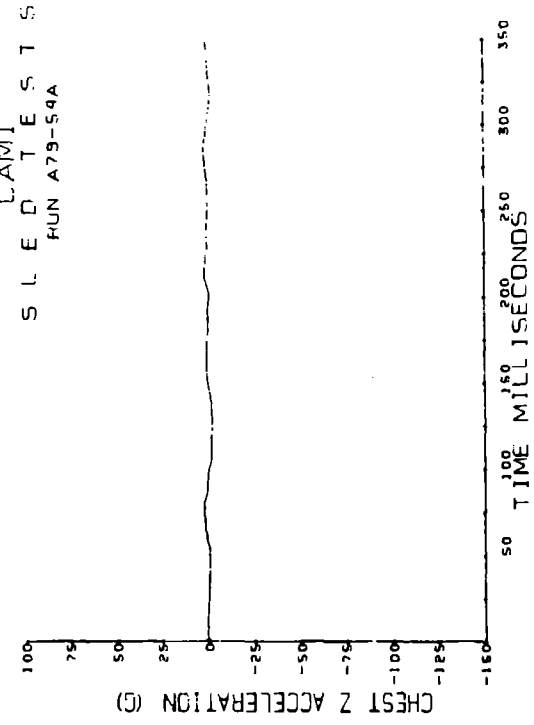
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S L E D T E S T S
RUN A79-54A



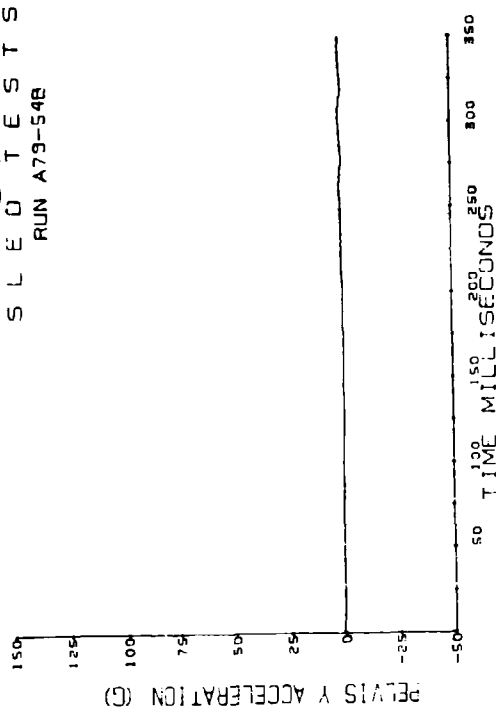
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S L E D T E S T S
RUN A79-54A



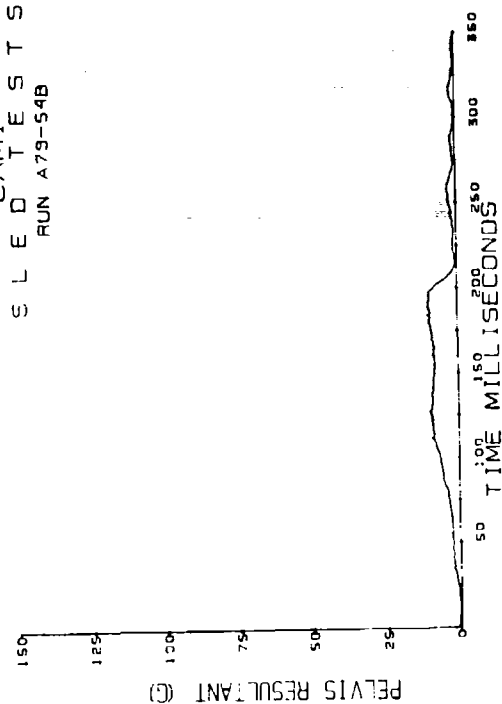
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S L E D T E S T S
RUN A79-54A



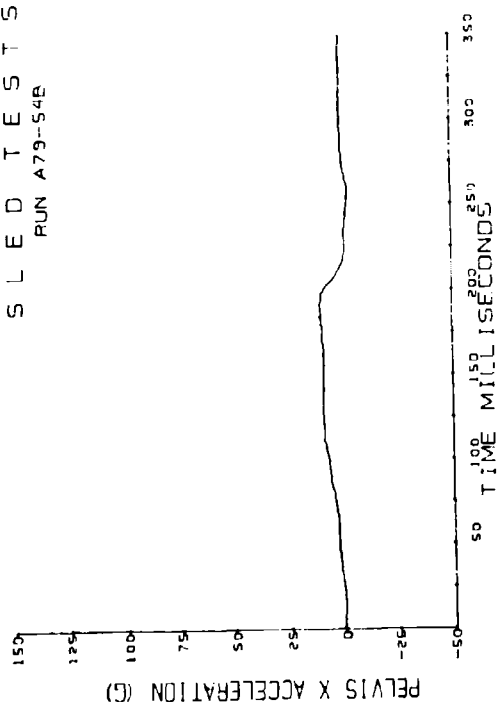
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RUN A79-54B



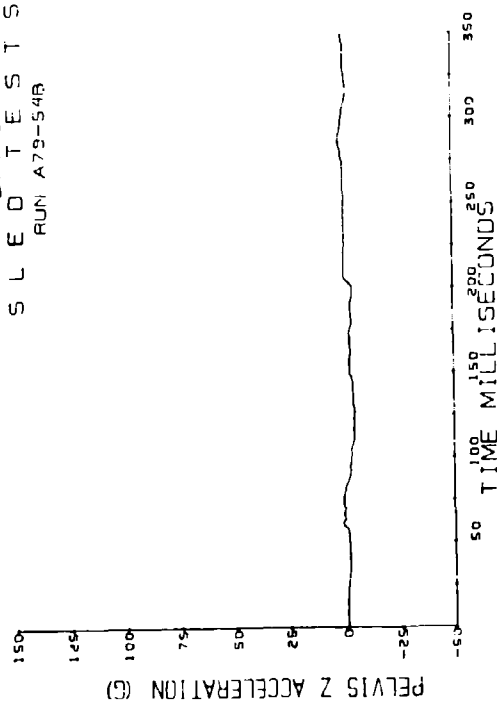
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S L E D T E S T S
RUN A79-54B



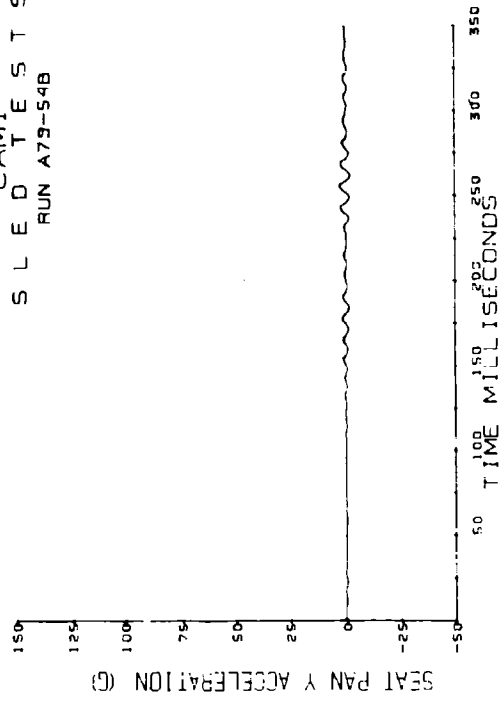
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S L E D T E S T S
RUN A79-54B



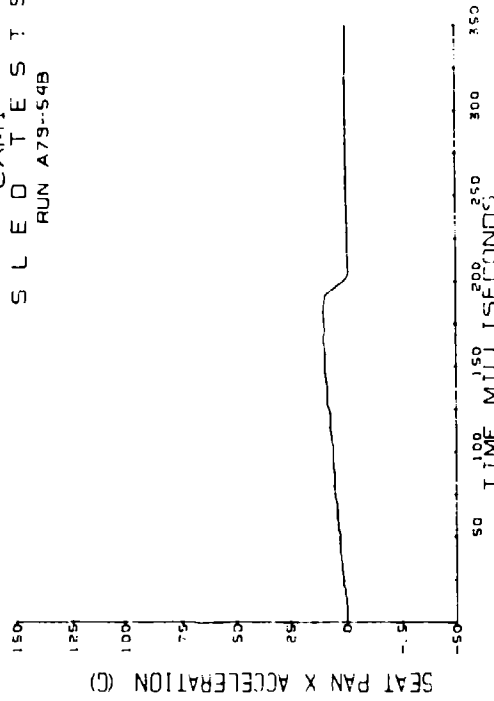
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S L E D T E S T S
RUN A79-54B



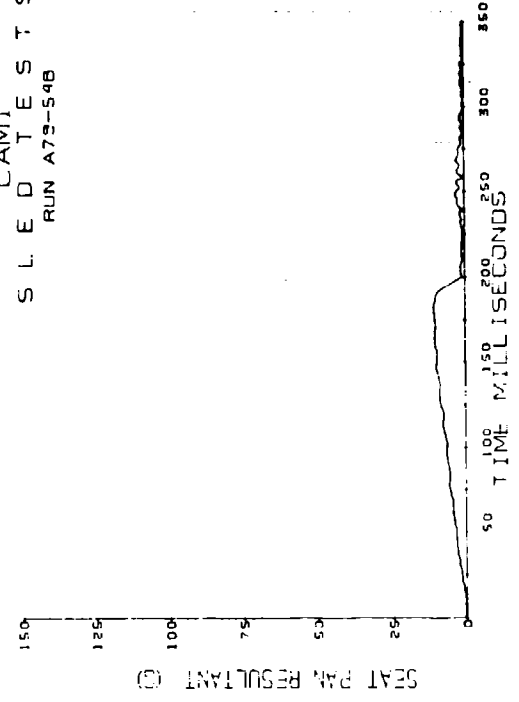
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S L E D T E S T S
RUN A79-54B



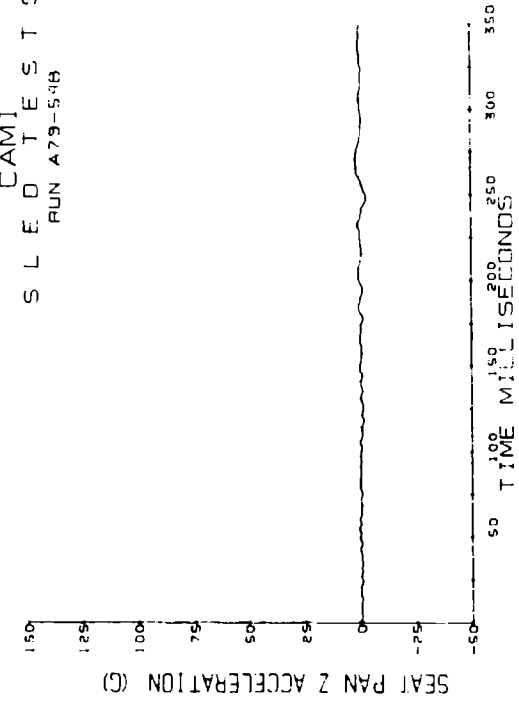
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S L E D T E S T S
RUN A79-54B



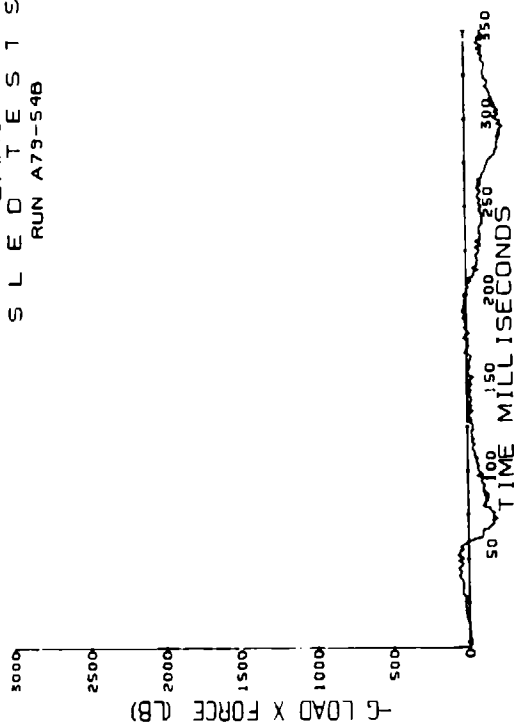
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S L E D T E S T S
RUN A79-54B



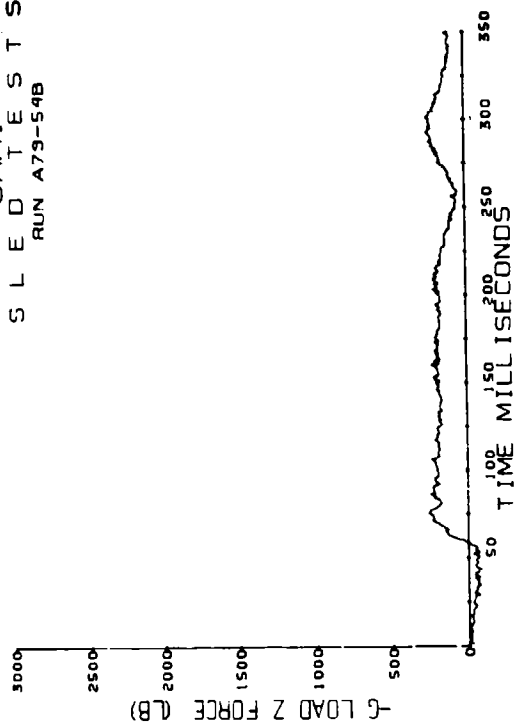
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S L E D T E S T S
RUN A79-54B

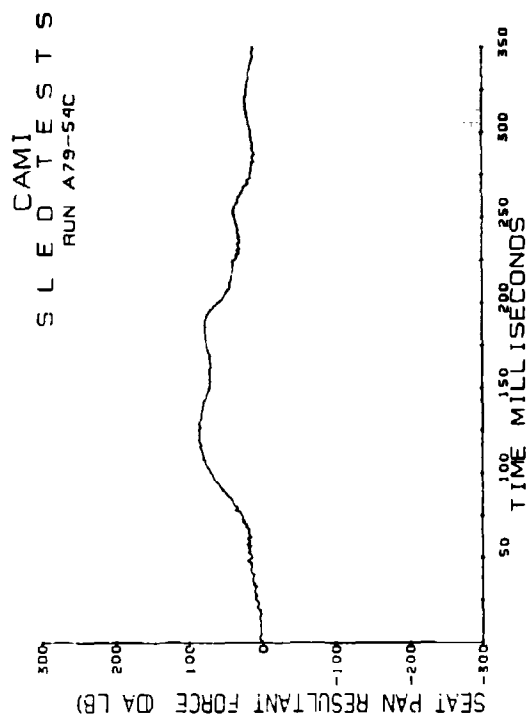
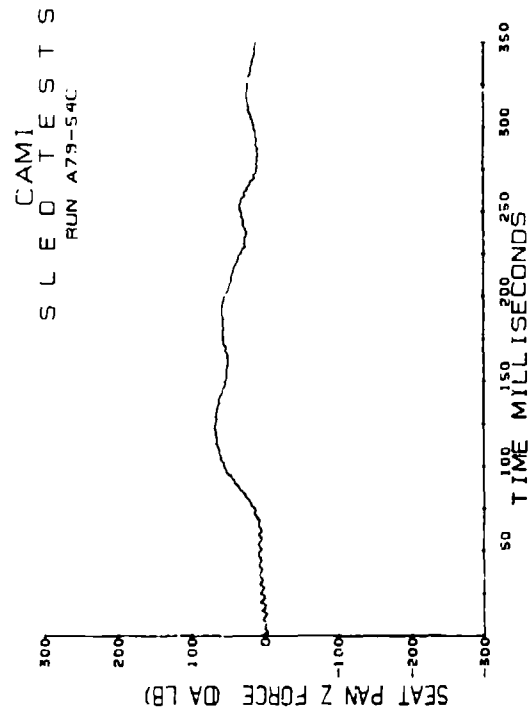
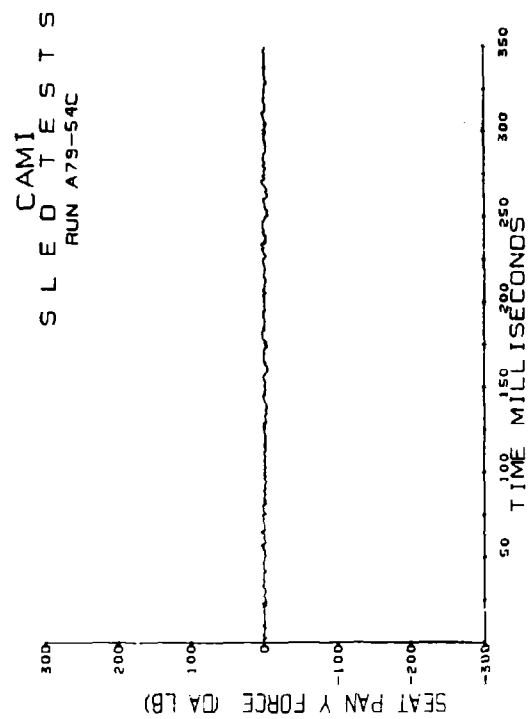
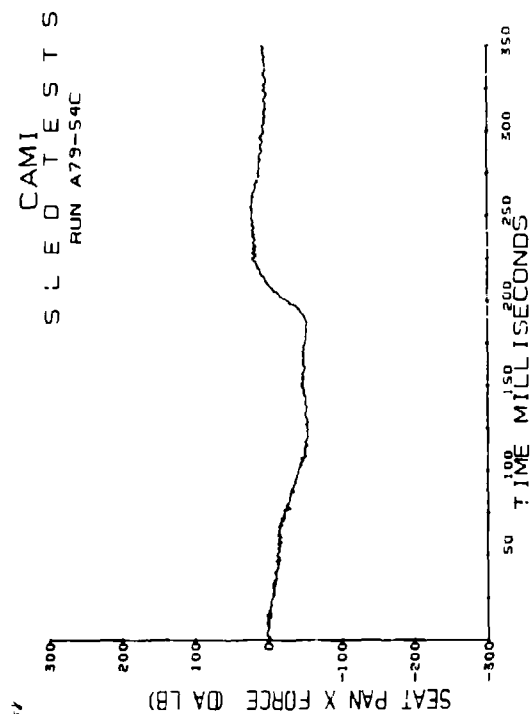


CAMI
S L E D T E S T S
RUN A79-54B

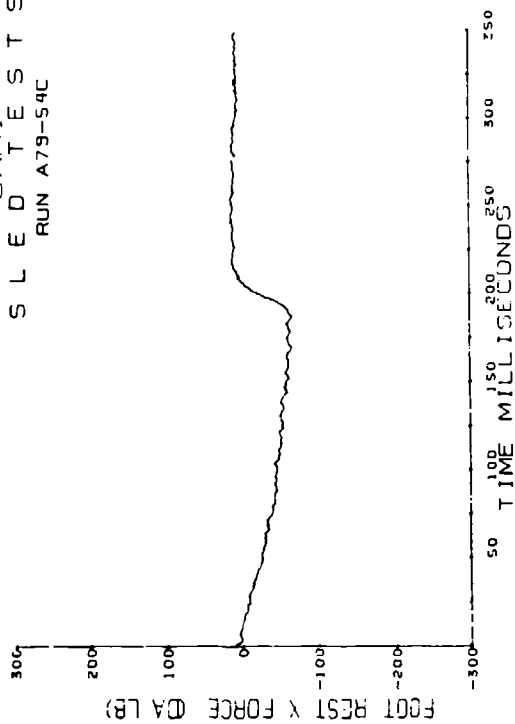


CAMI
S L E D T E S T S
RUN A79-54B

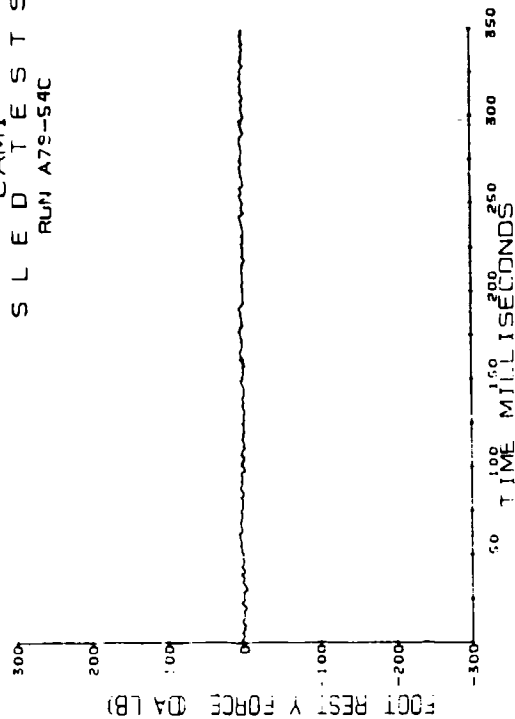




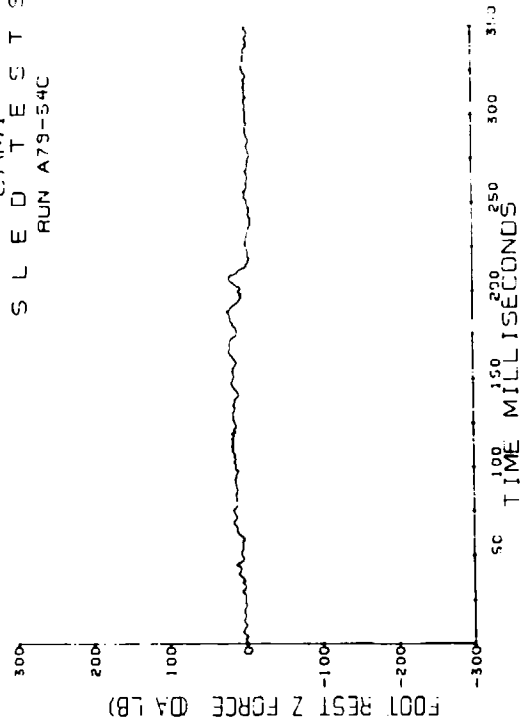
CAMI
S L E D T E S T S
RUN A79-54C



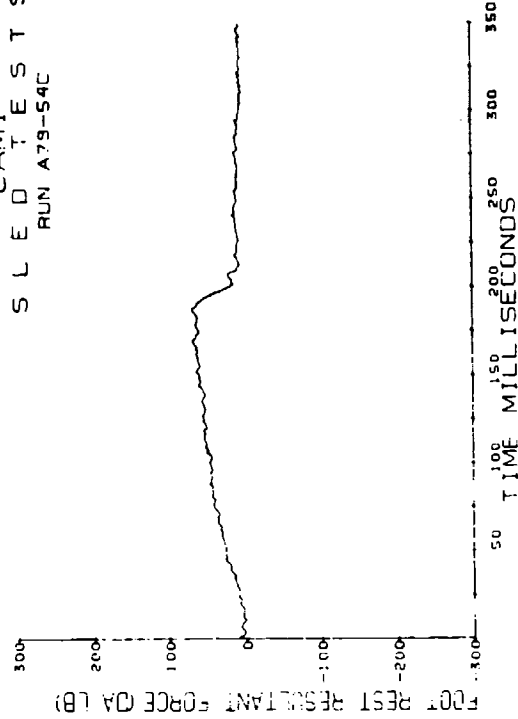
CAMI
S L E D T E S T S
RUN A79-54C



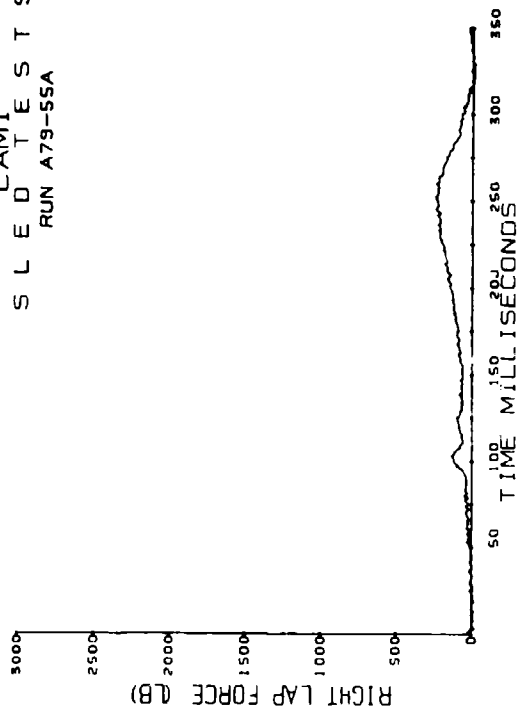
CAMI
S L E D T E S T S
RUN A79-54C



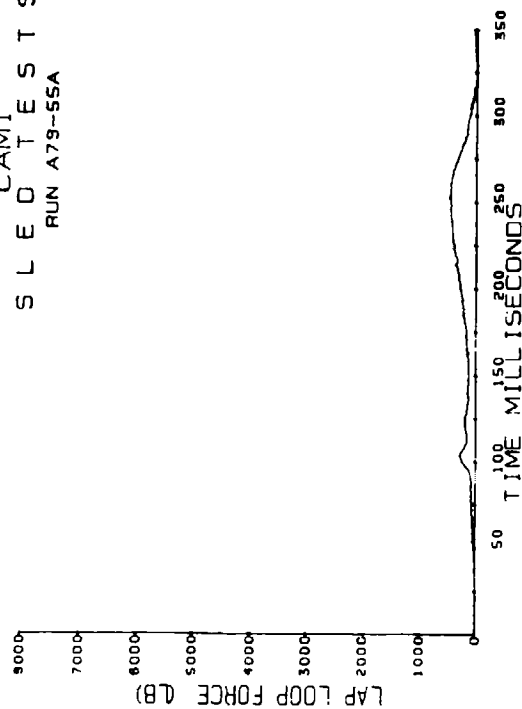
CAMI
S L E D T E S T S
RUN A79-54C



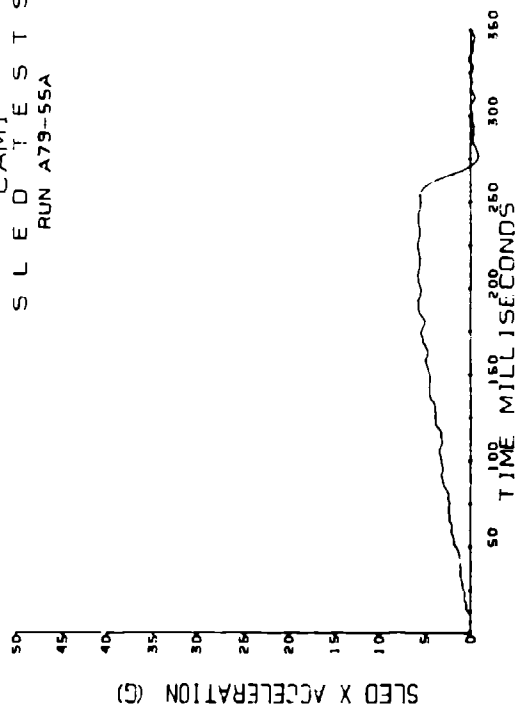
CAMI
S L E D T E S T S
RUN A79-55A



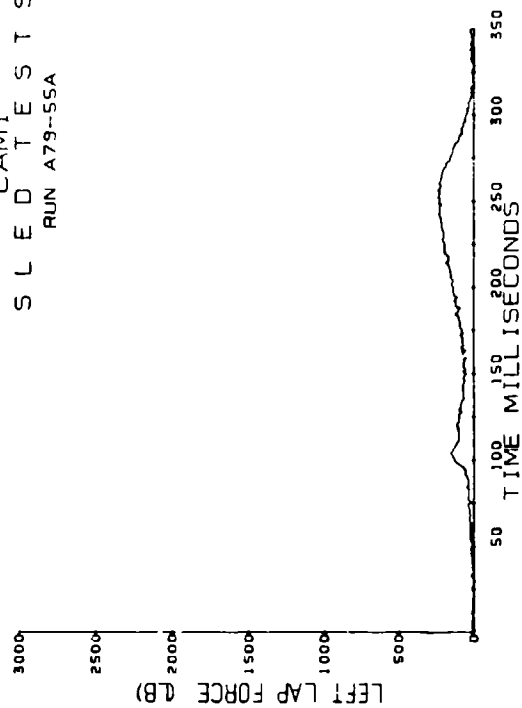
CAMI
S L E D T E S T S
RUN A79-55A

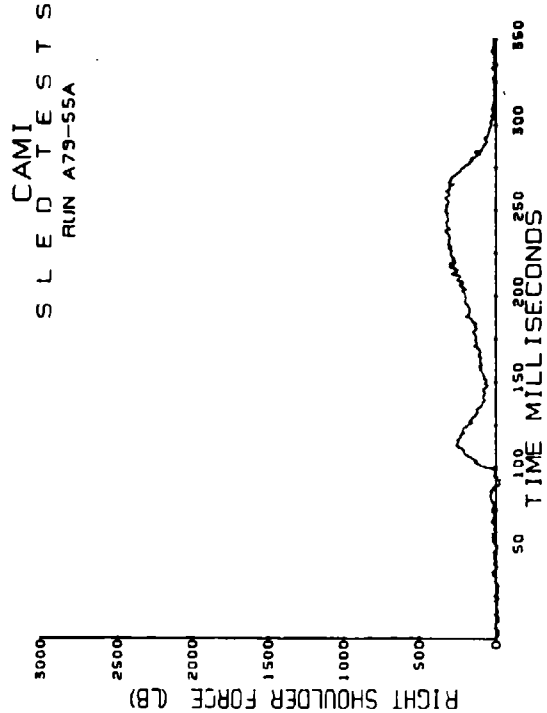
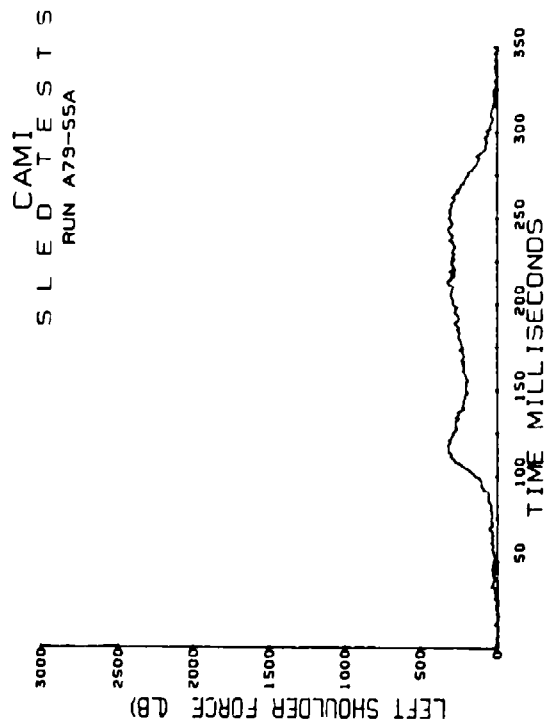


CAMI
S L E D T E S T S
RUN A79-55A

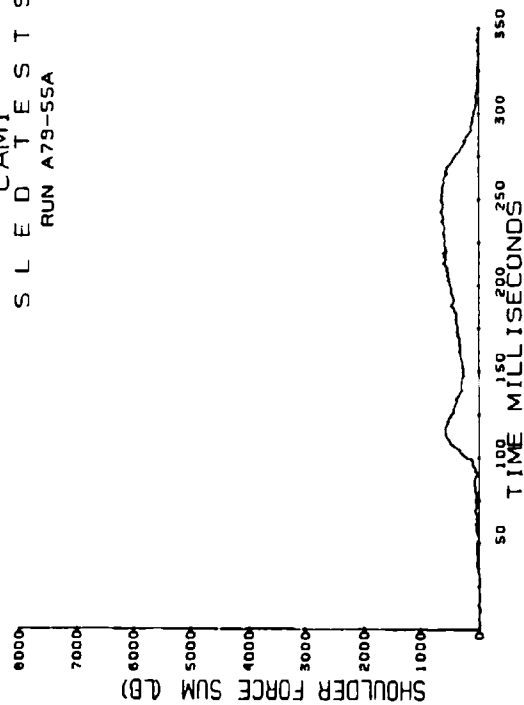


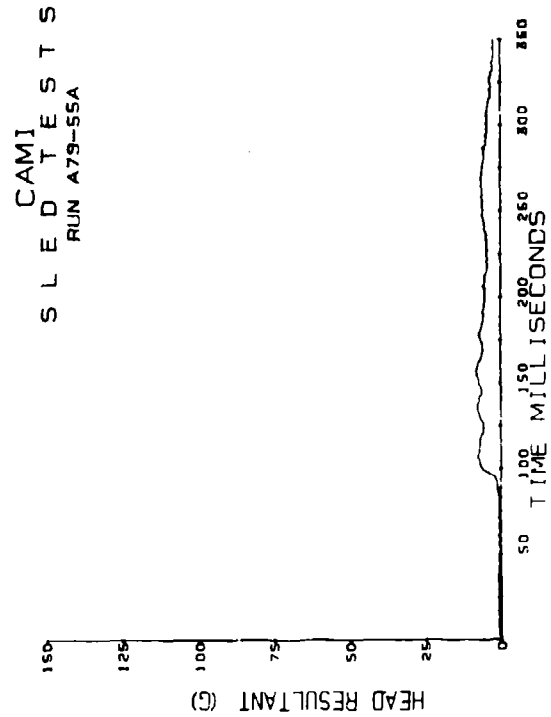
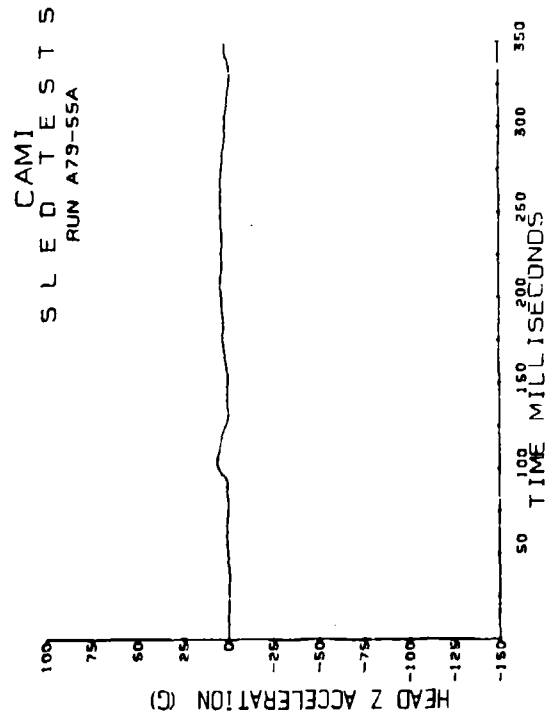
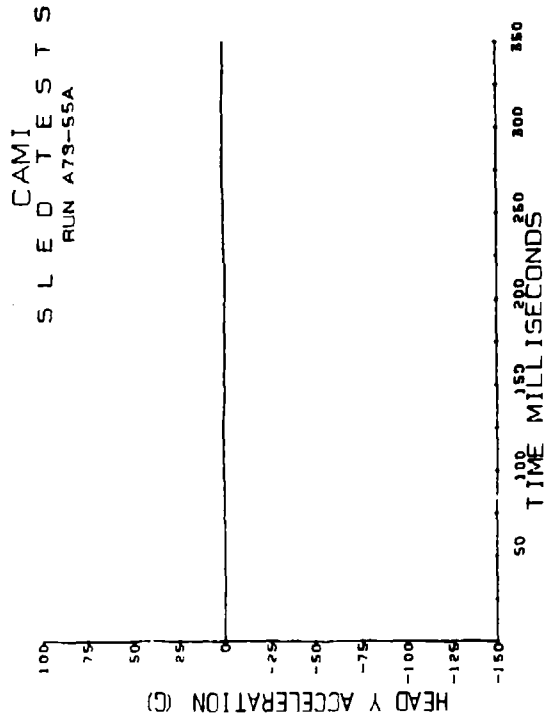
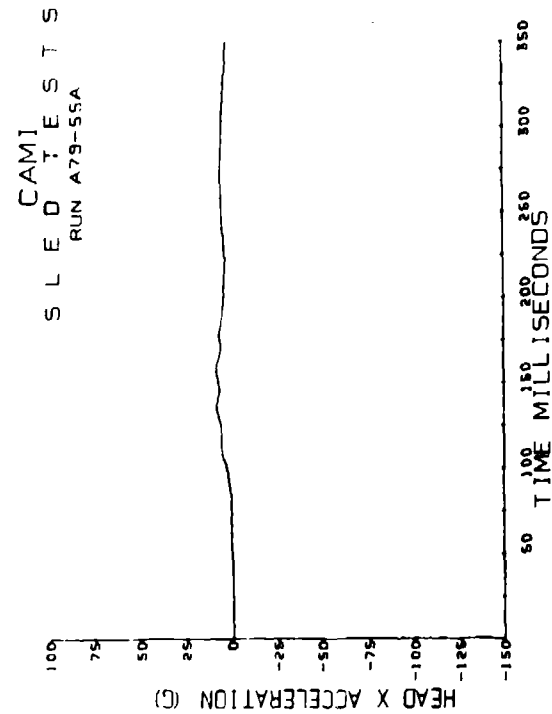
CAMI
S L E D T E S T S
RUN A79-55A

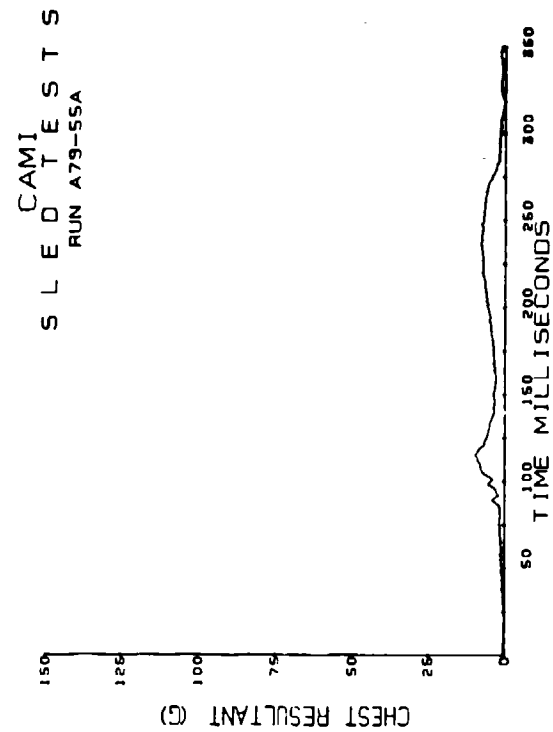
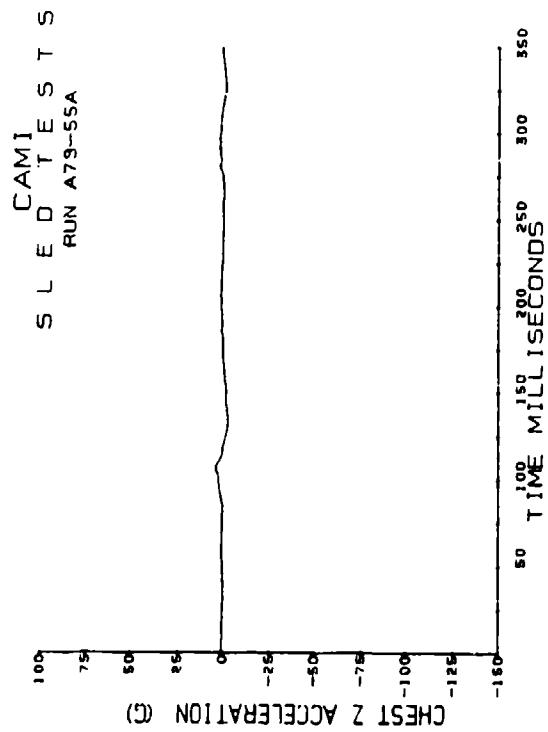
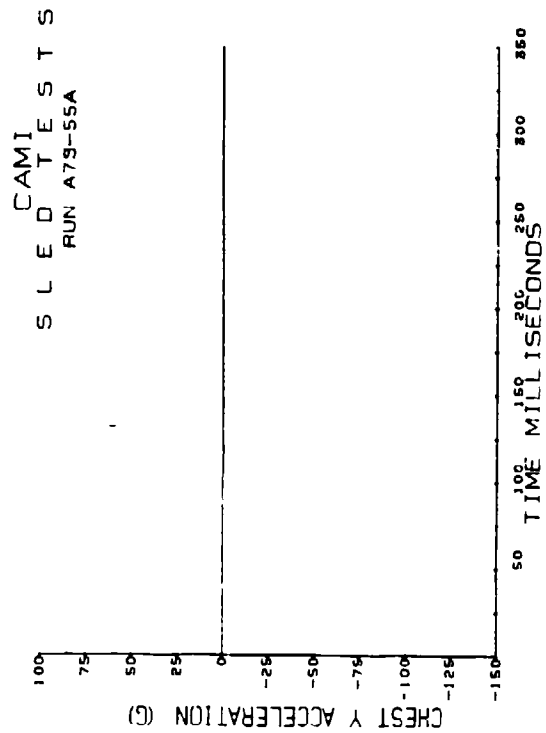
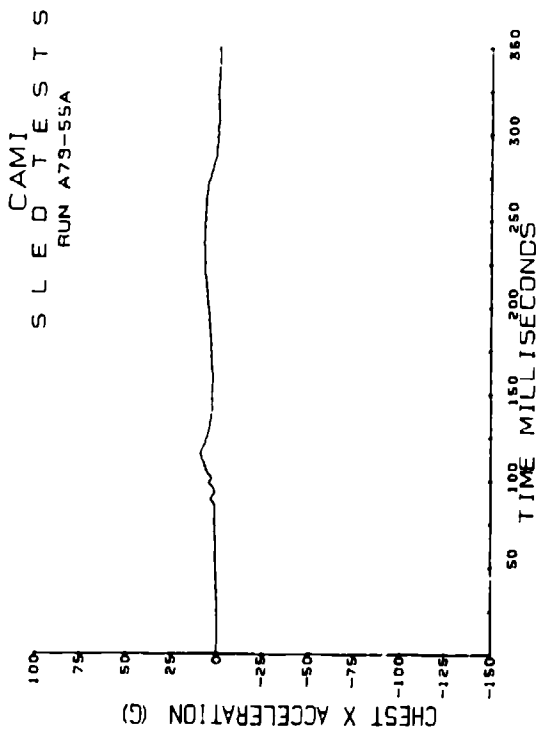


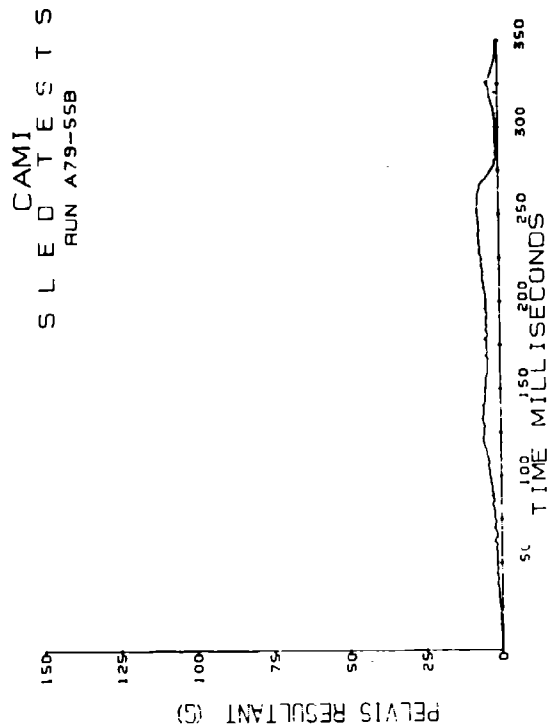
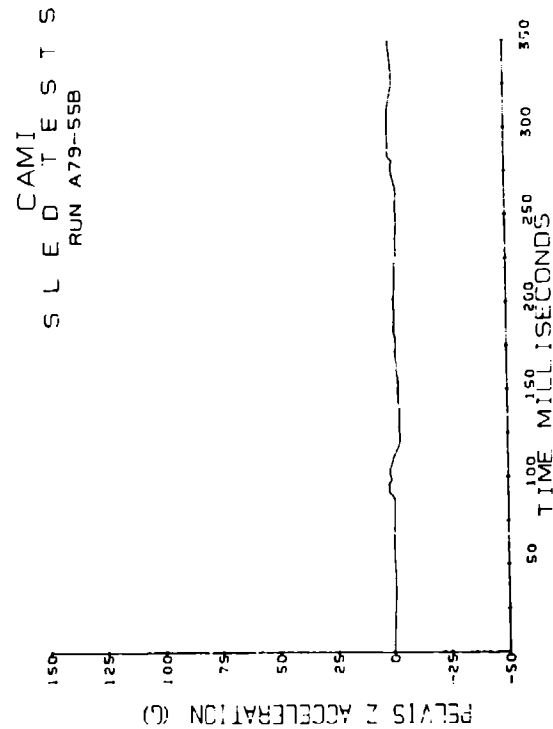
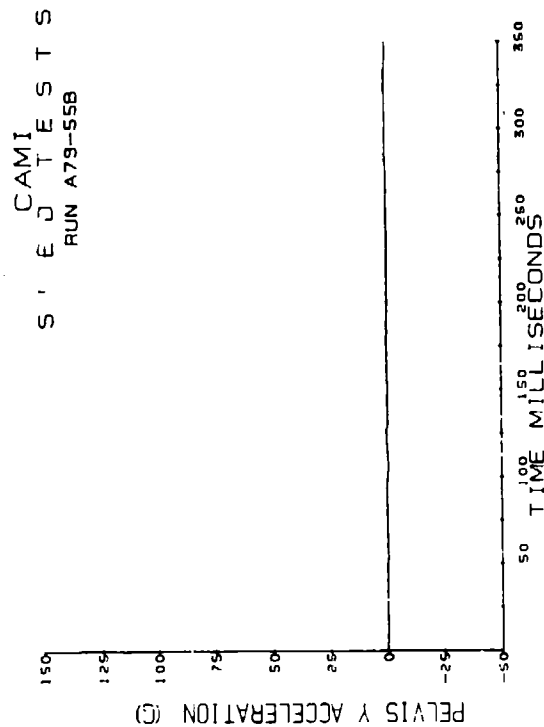
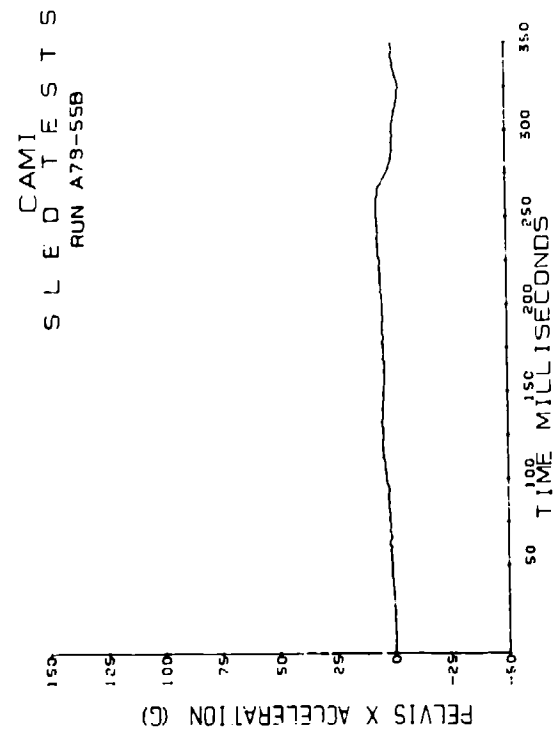


CAMI
S L E D T E S T S
RUN A79-55A

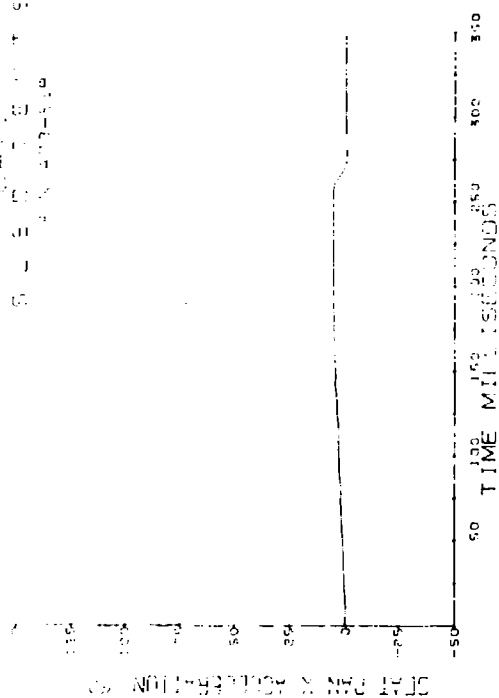




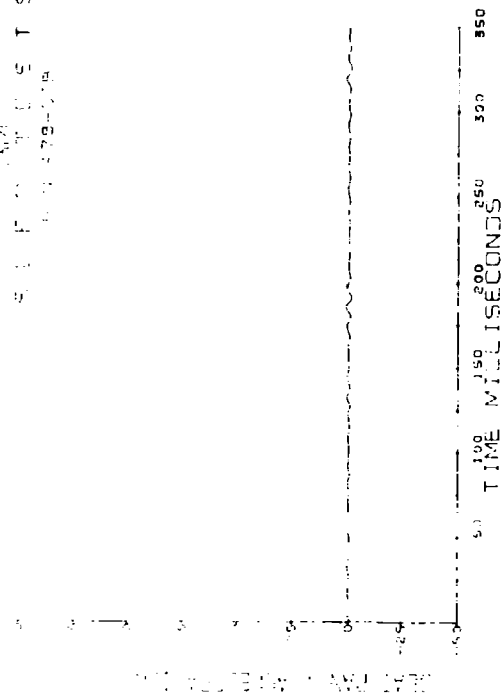




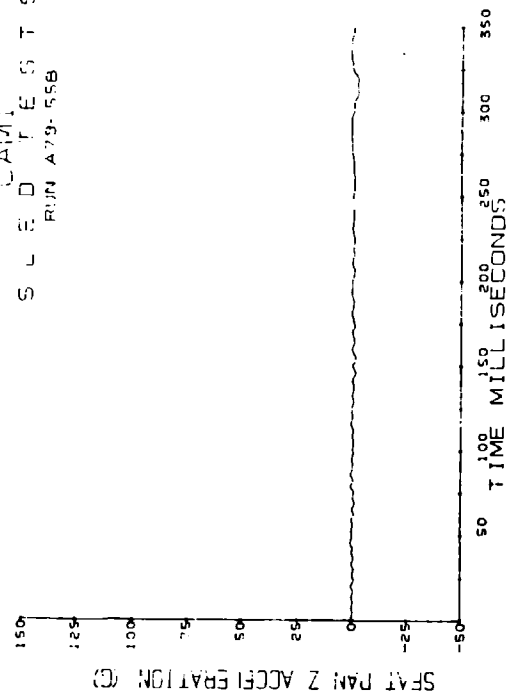
CAM1
S L E D T E S T S
RUN A79-558



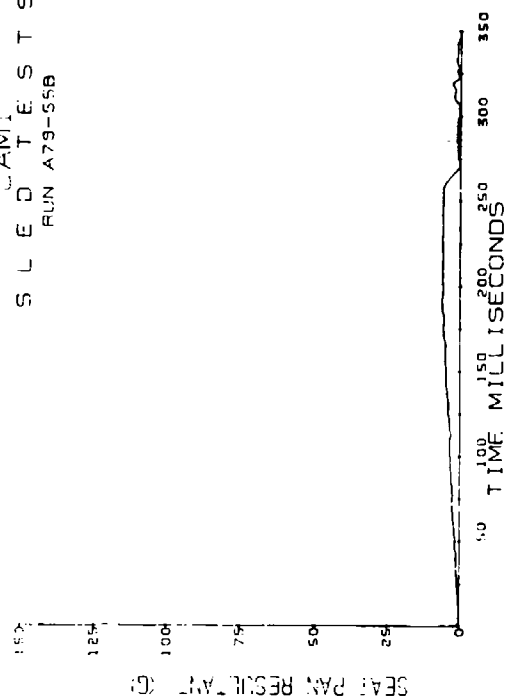
CAM1
S L E D T E S T S
RUN A79-558



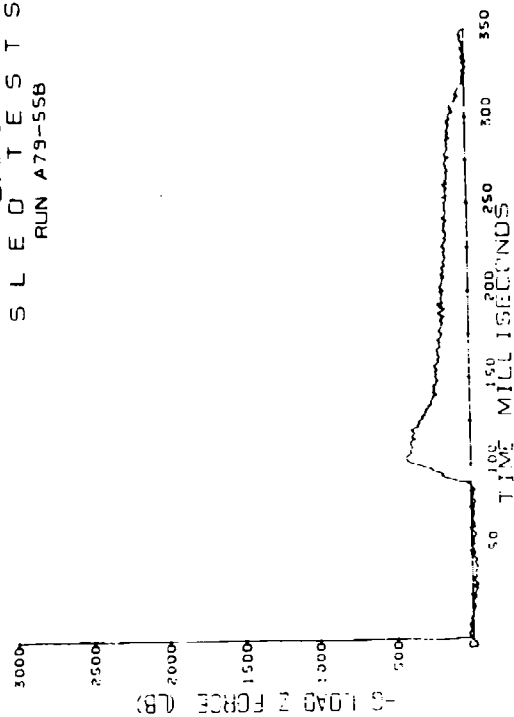
CAM1
S L E D T E S T S
RUN A79-558



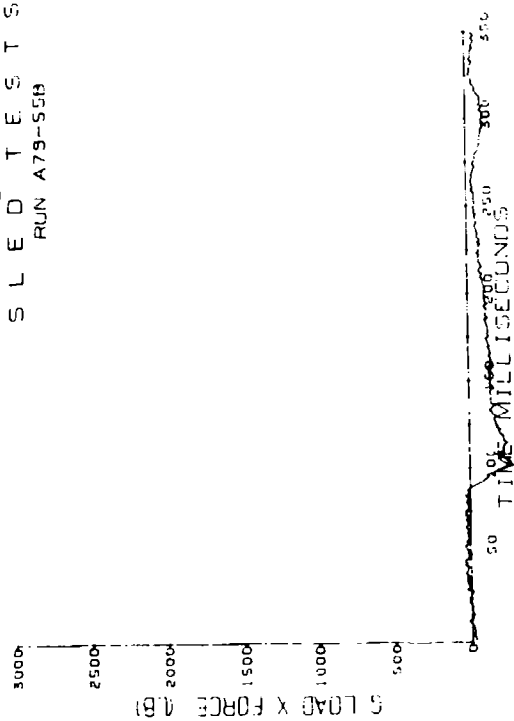
CAM1
S L E D T E S T S
RUN A79-558

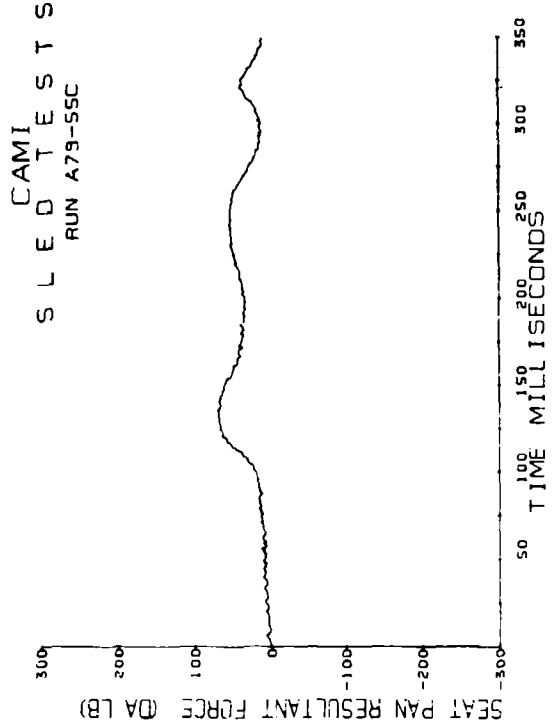
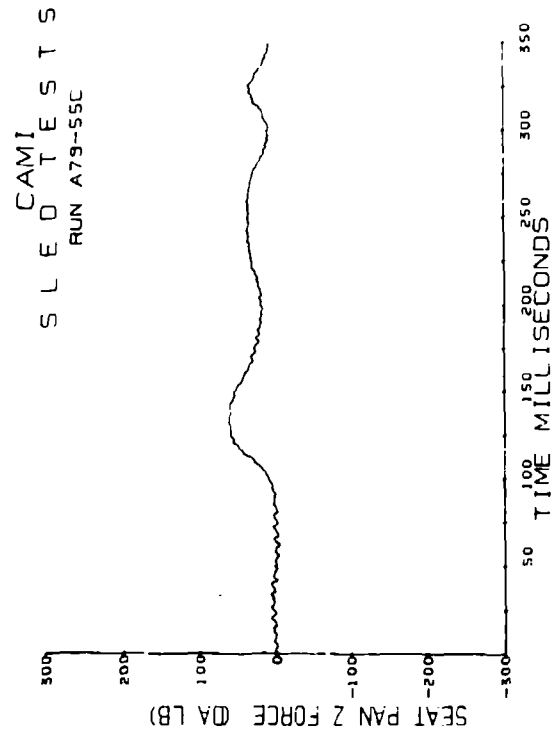
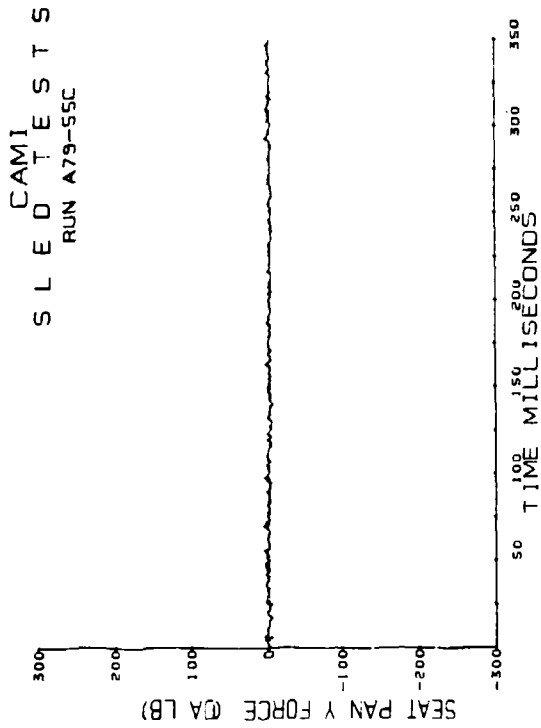
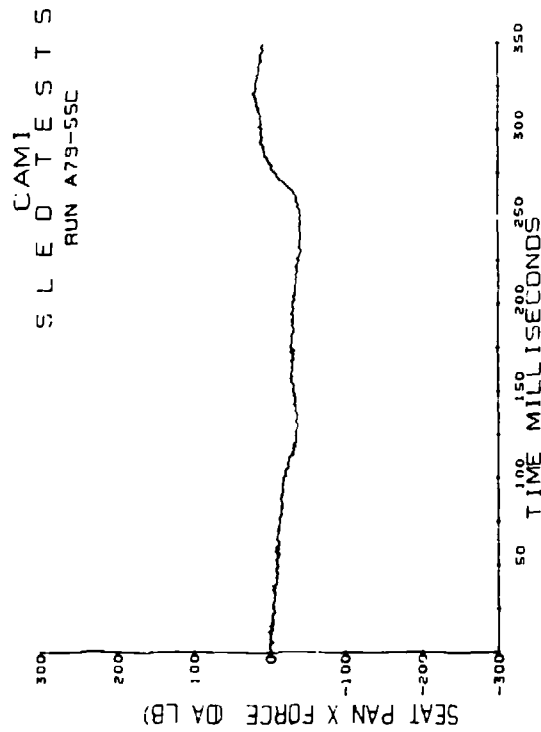


CAMI
S L E D T E S T S
RUN A79-55B

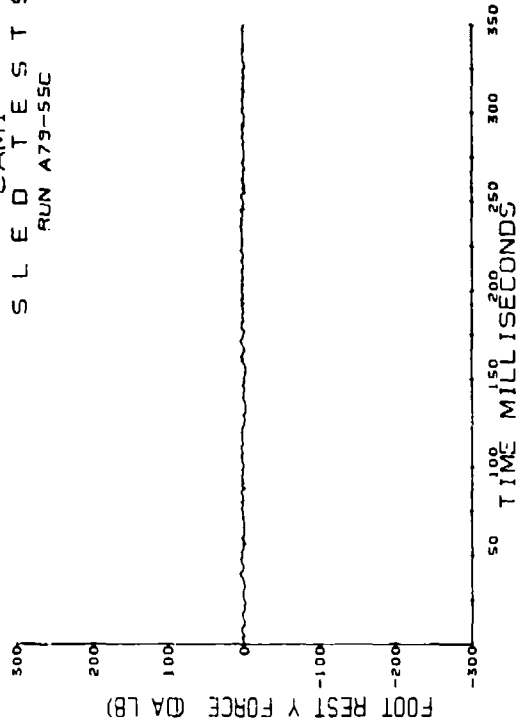


CAMI
S L E D T E S T S
RUN A79-55B

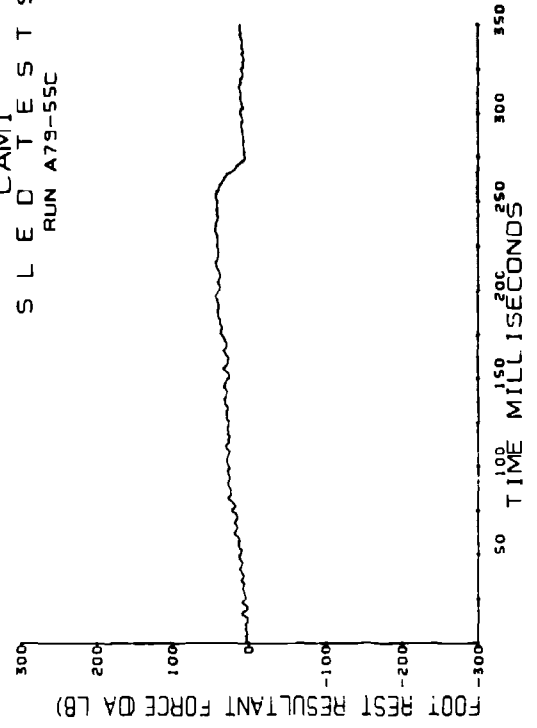




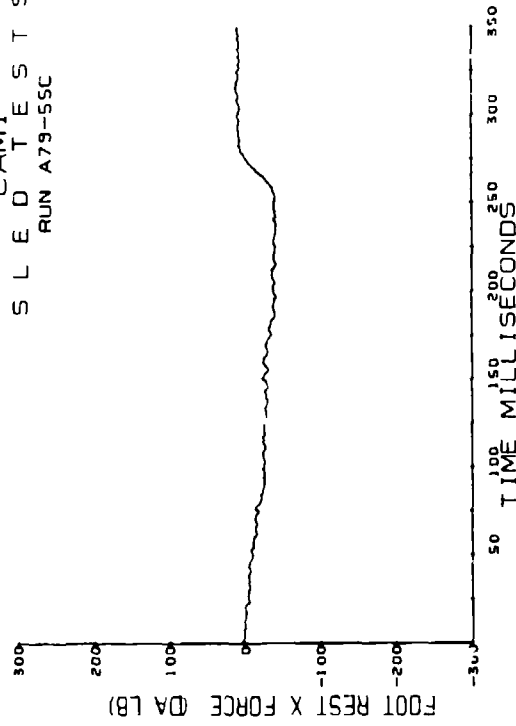
CAMI
S L E D T E S T S
RUN A79-55C



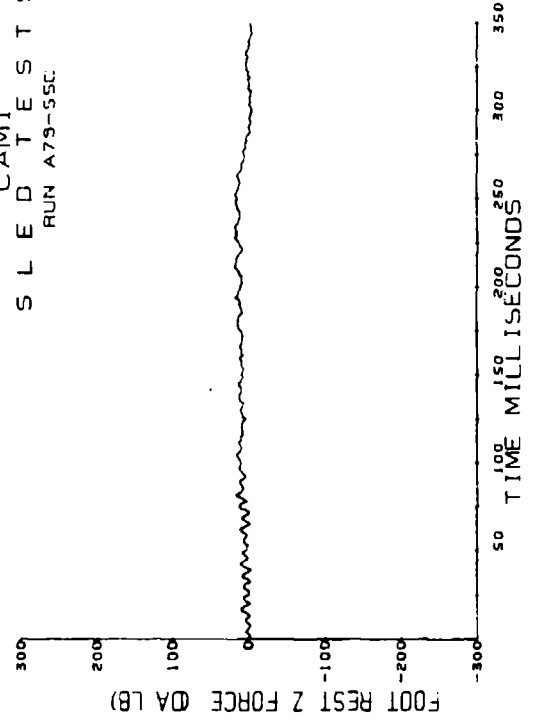
CAMI
S L E D T E S T S
RUN A79-55C



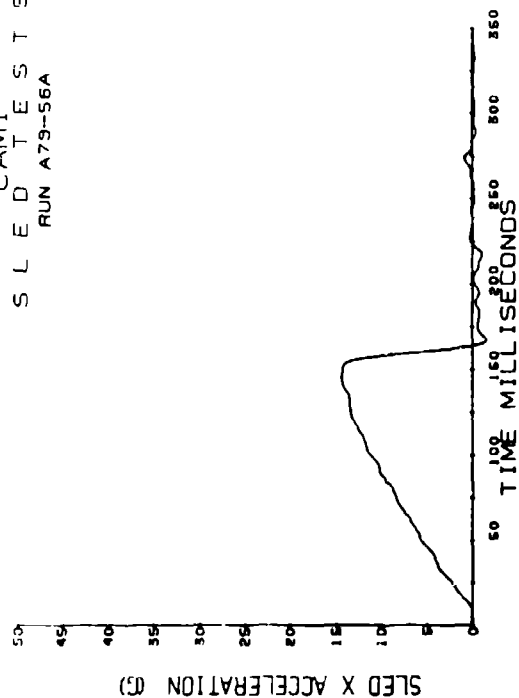
CAMI
S L E D T E S T S
RUN A79-55C



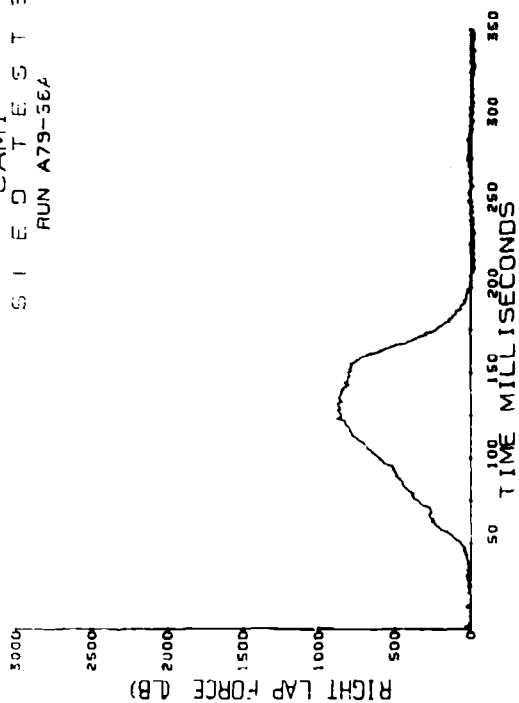
CAMI
S L E D T E S T S
RUN A79-55C



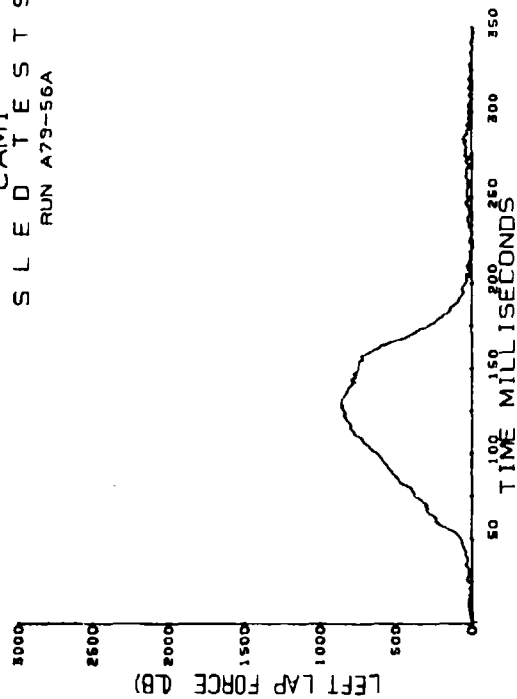
CAMI
S L E D T E S T S
RUN A79-56A



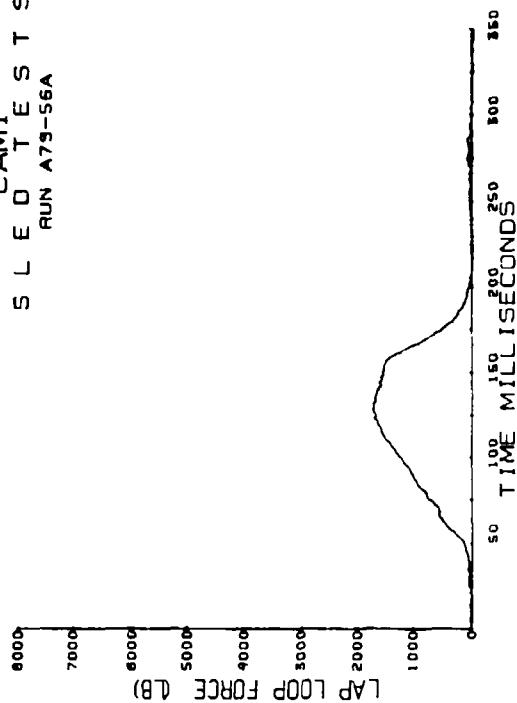
CAMI
S L E D T E S T S
RUN A79-56A

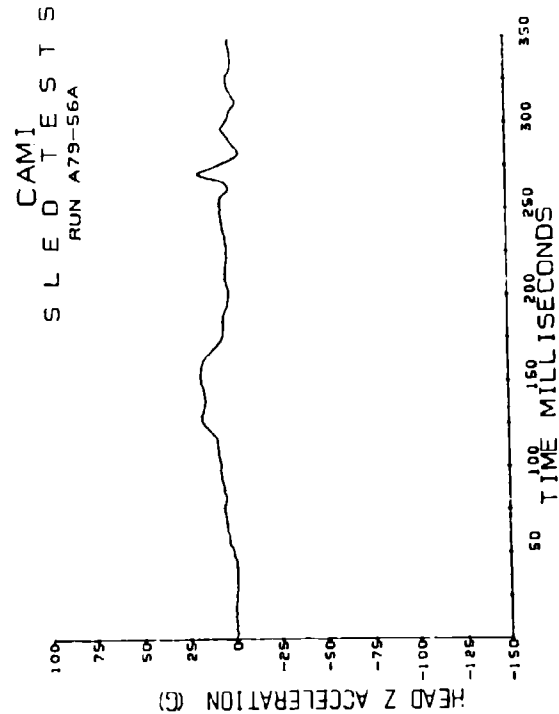
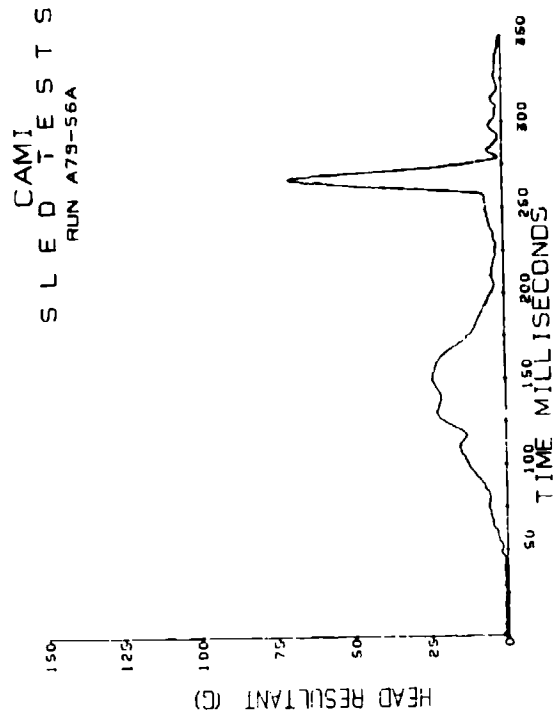
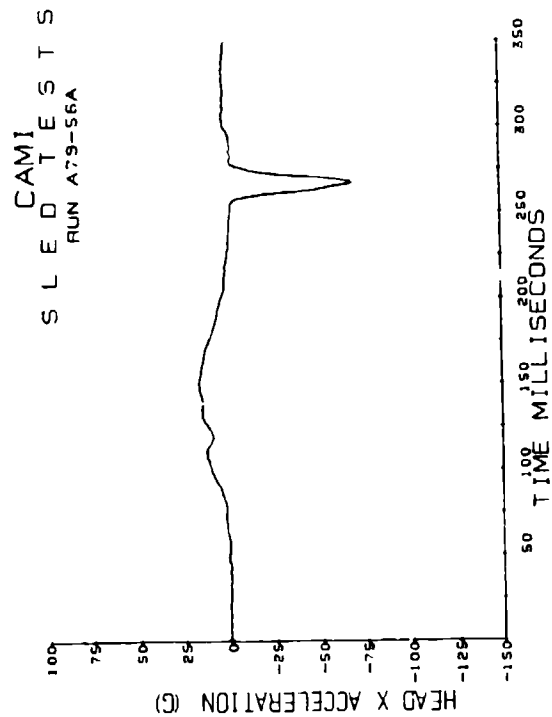
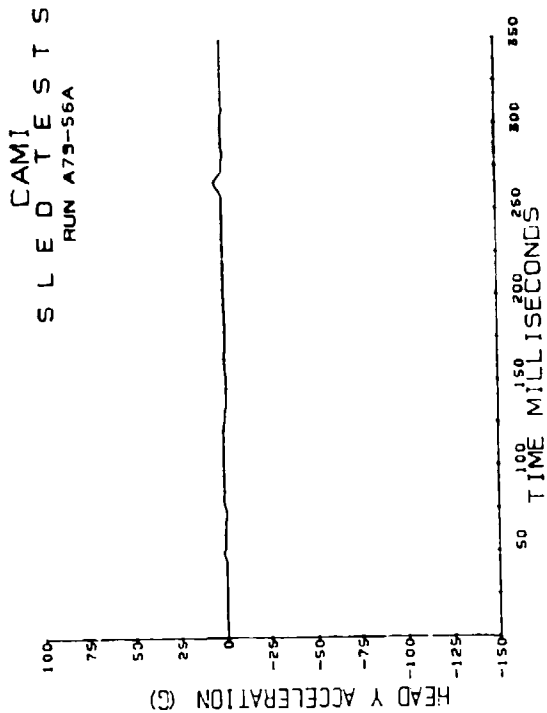


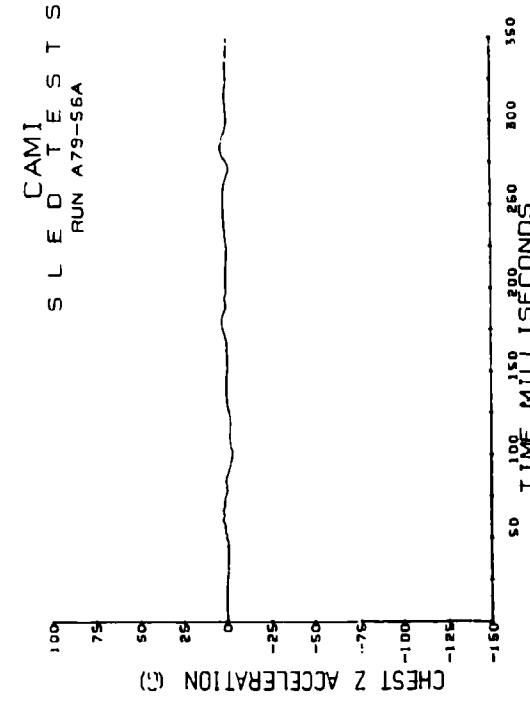
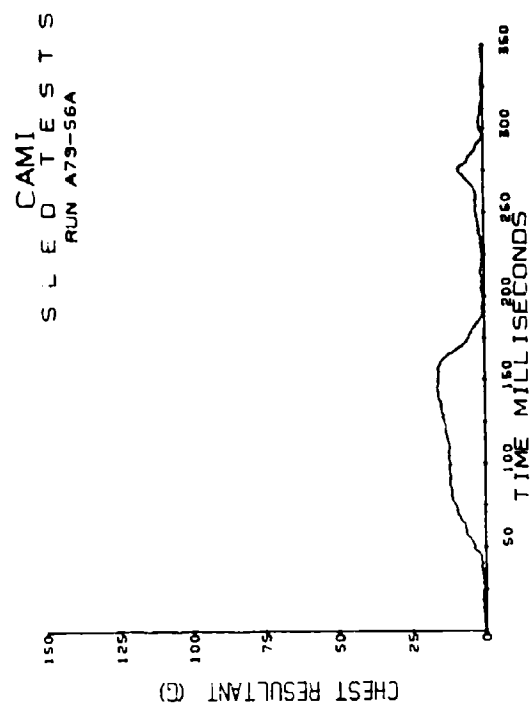
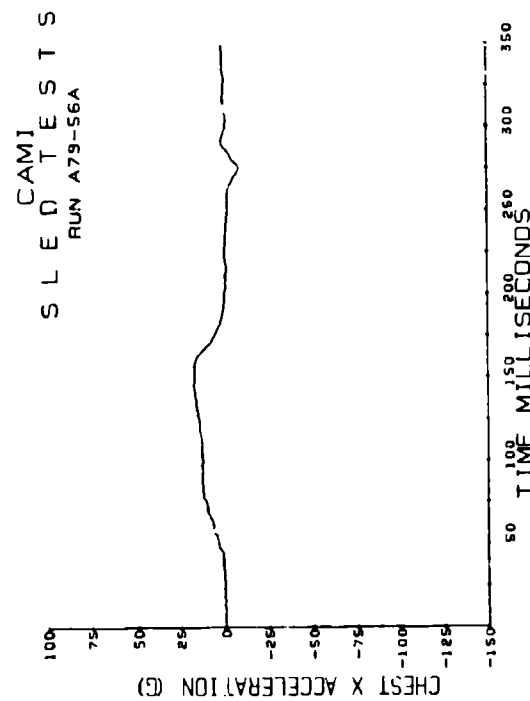
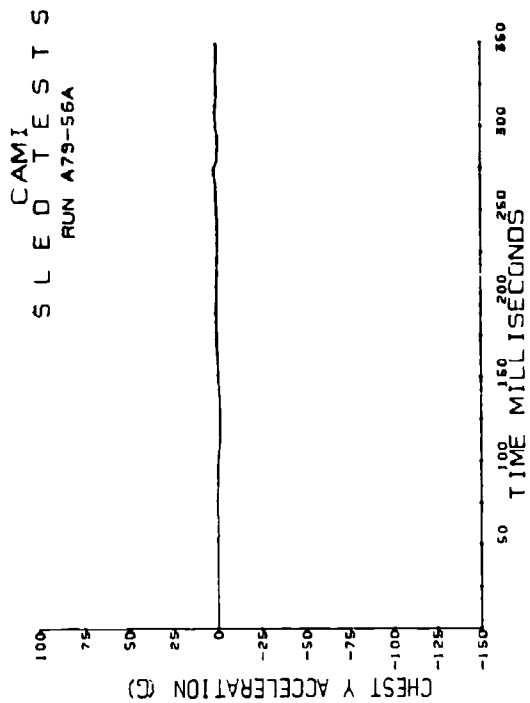
CAMI
S L E D T E S T S
RUN A79-56A



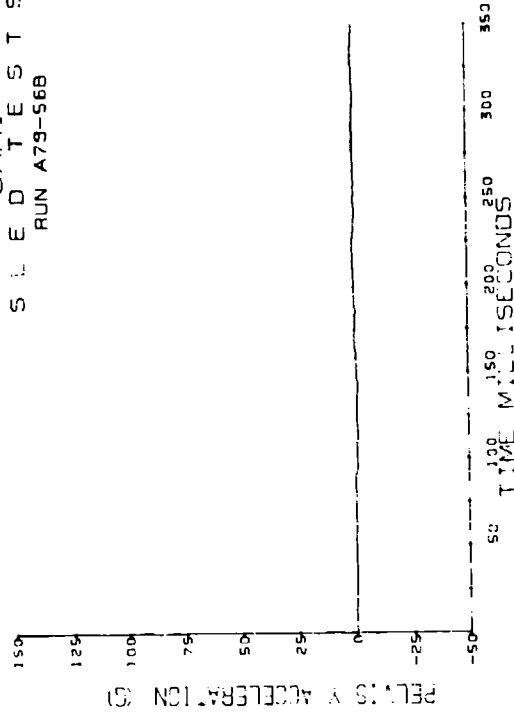
CAMI
S L E D T E S T S
RUN A79-56A



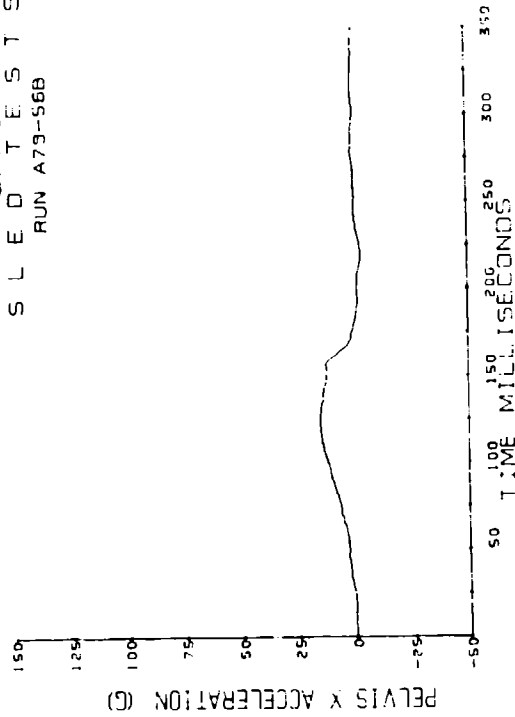




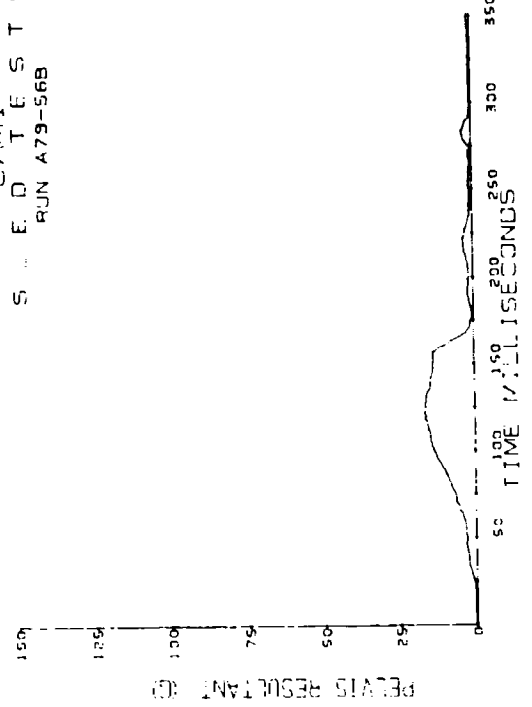
CAMI
S L E D T E S T S
RUN A79-56B



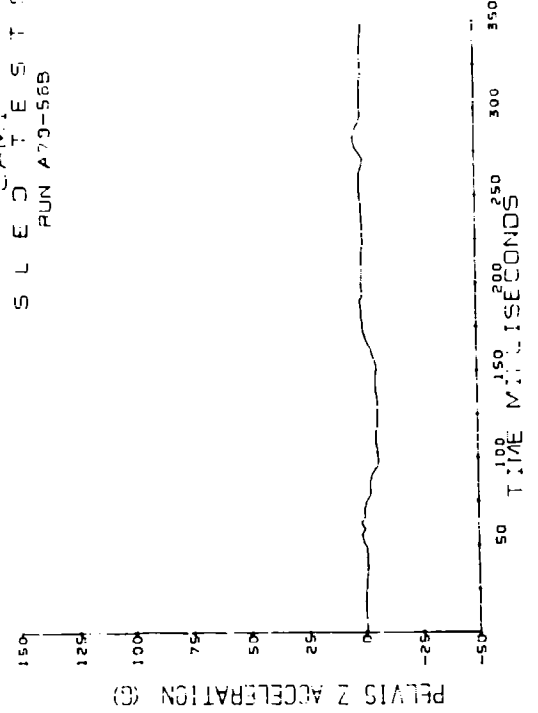
CAMI
S L E D T E S T S
RUN A79-56B

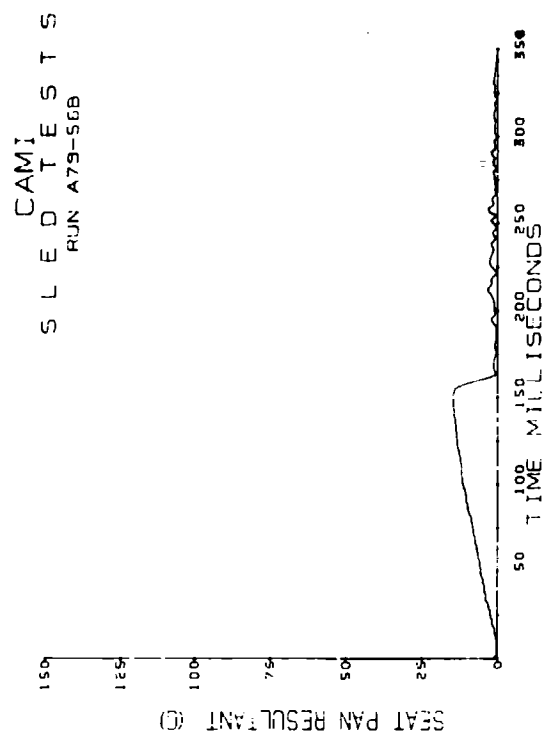
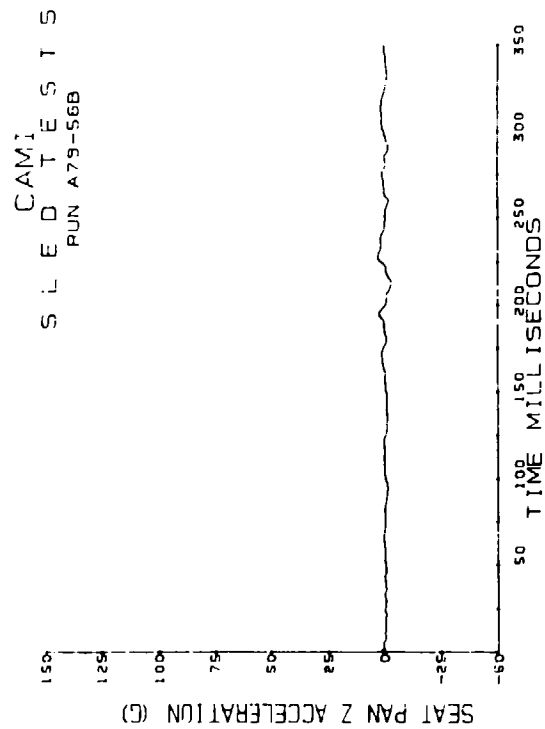
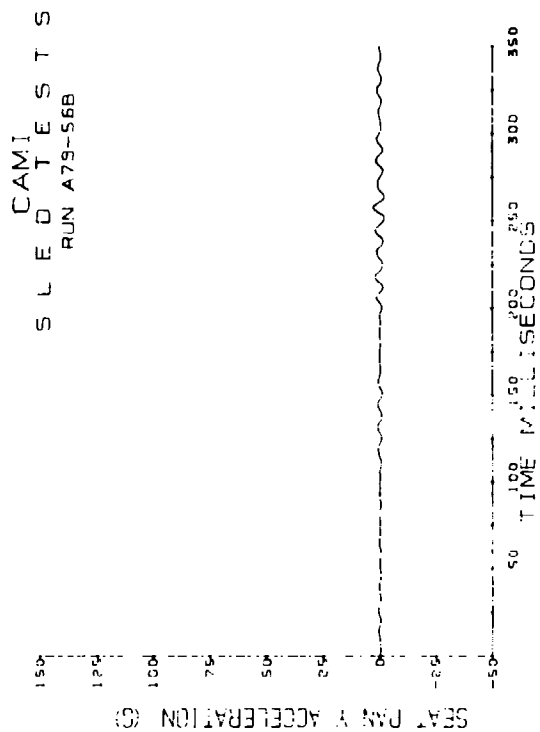
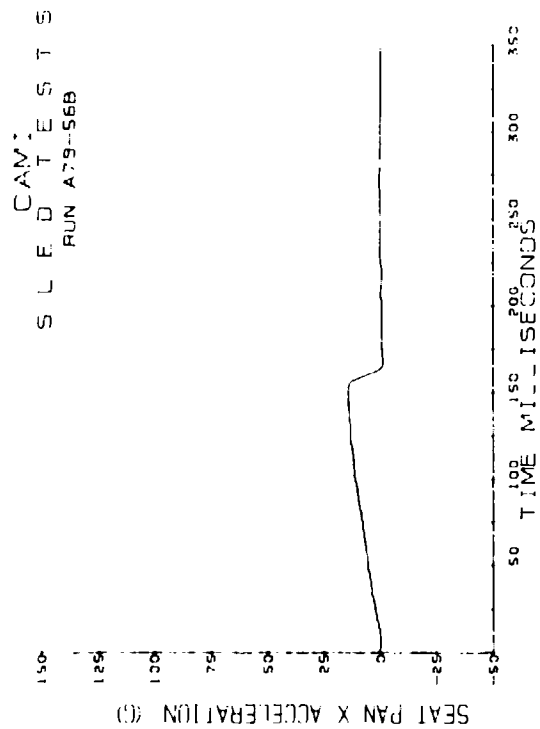


CAMI
S L E D T E S T S
RUN A79-56B

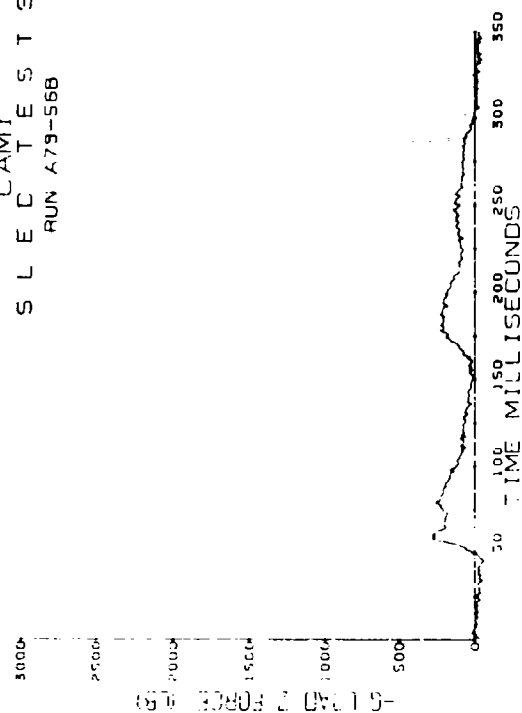


CAMI
S L E D T E S T S
RUN A79-56B

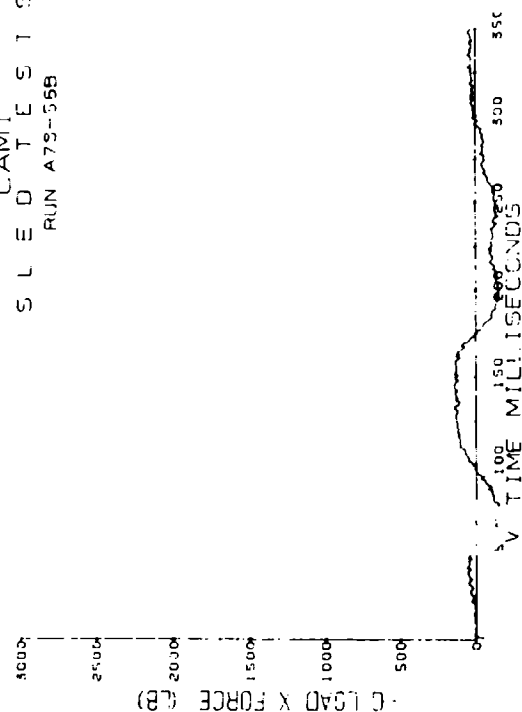




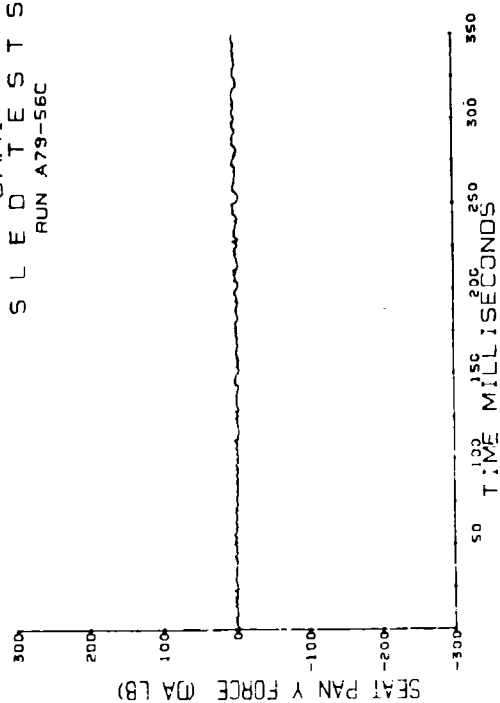
CAMI
S L E D T E S T S
RUN 479-568



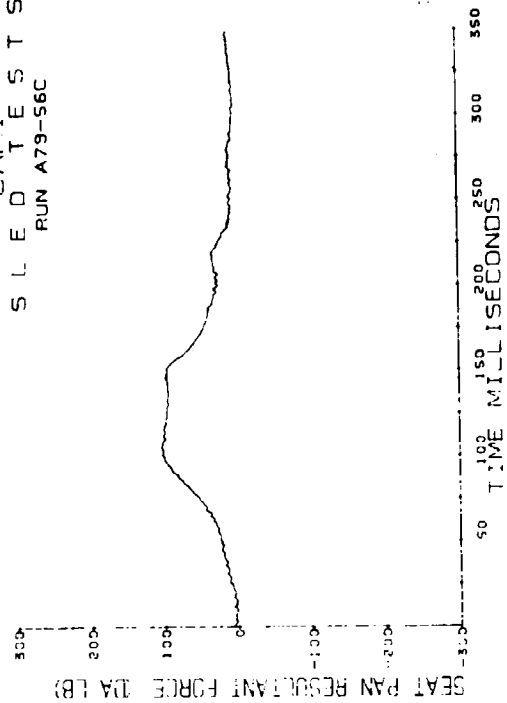
CAMI
S L E D T E S T S
RUN 479-568



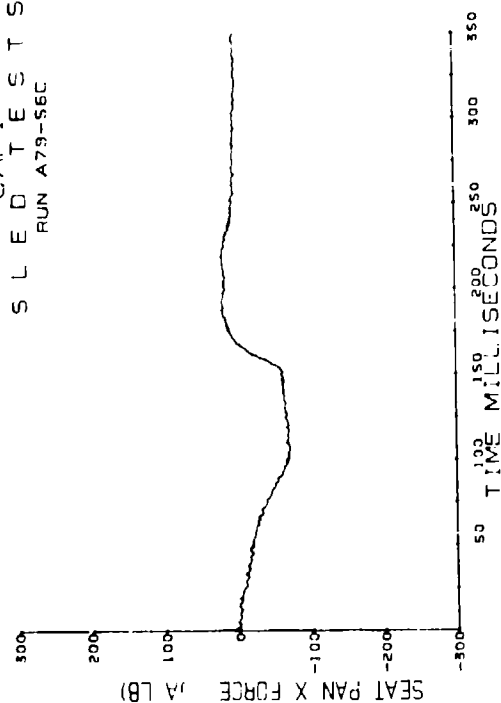
CAMI
S L E D T E S T S
RUN A79-56C



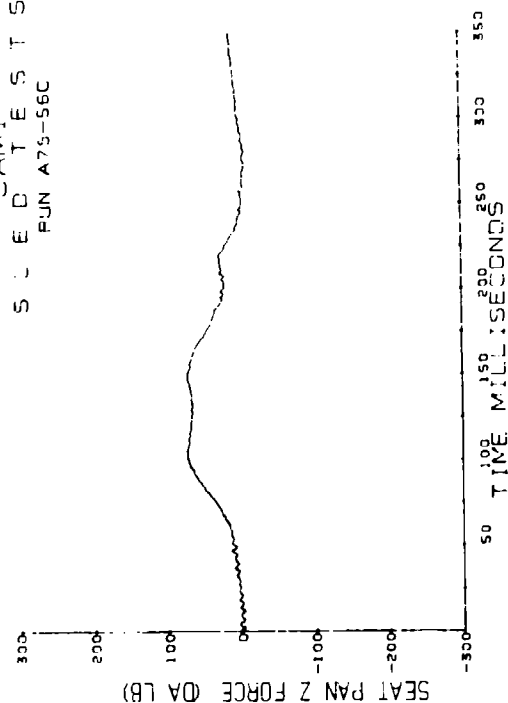
CAMI
S L E D T E S T S
RUN A79-56C



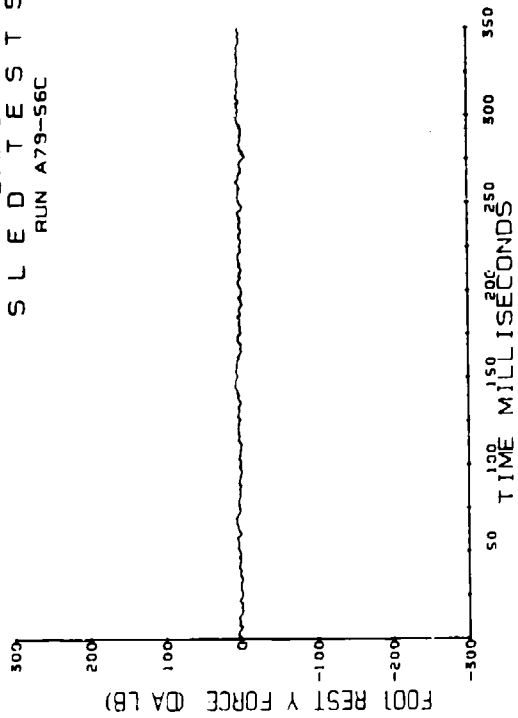
CAMI
S L E D T E S T S
RUN A79-56C



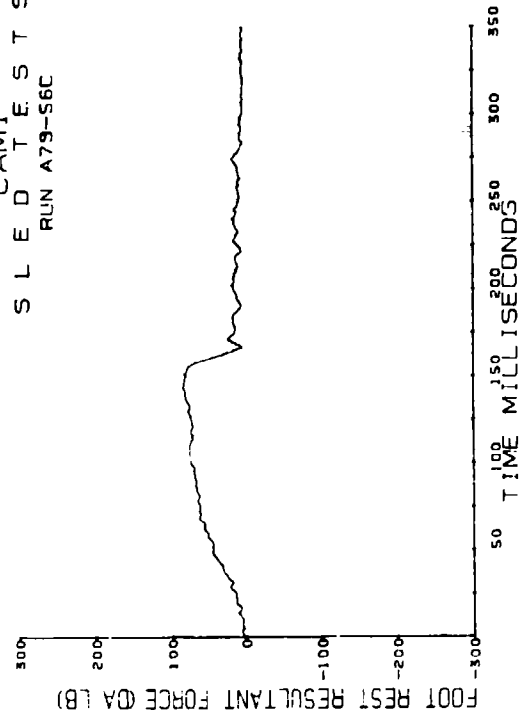
CAMI
S L E D T E S T S
RUN A79-56C



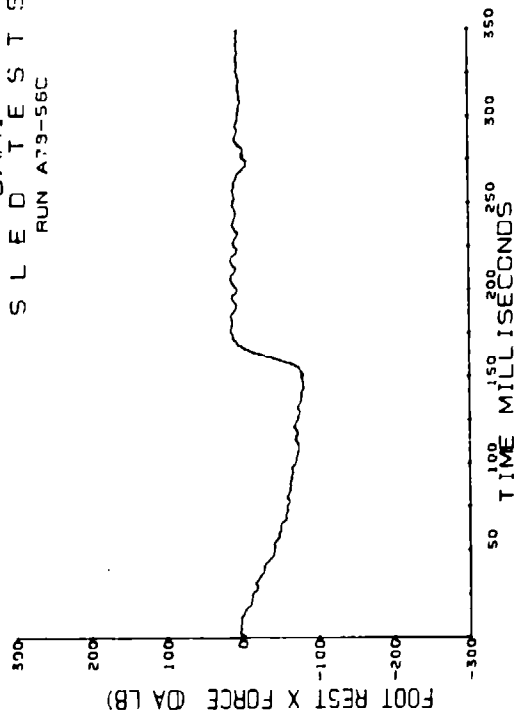
CAMI S L E D T E S T S RUN A79-56C



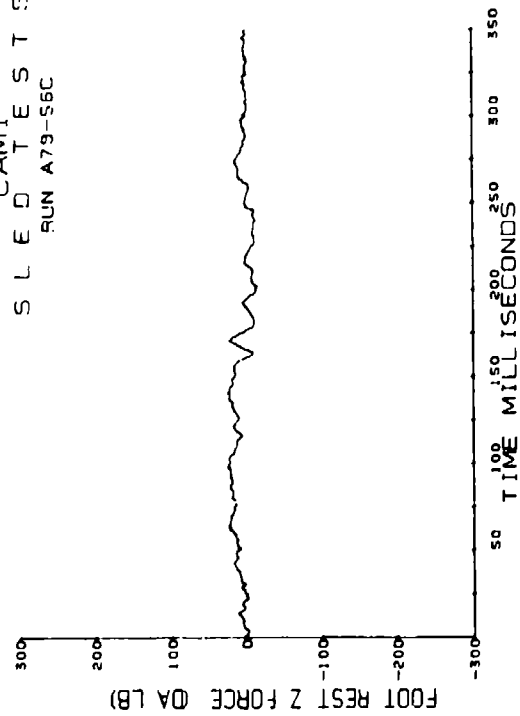
CAMI S L E D T E S T S RUN A79-56C



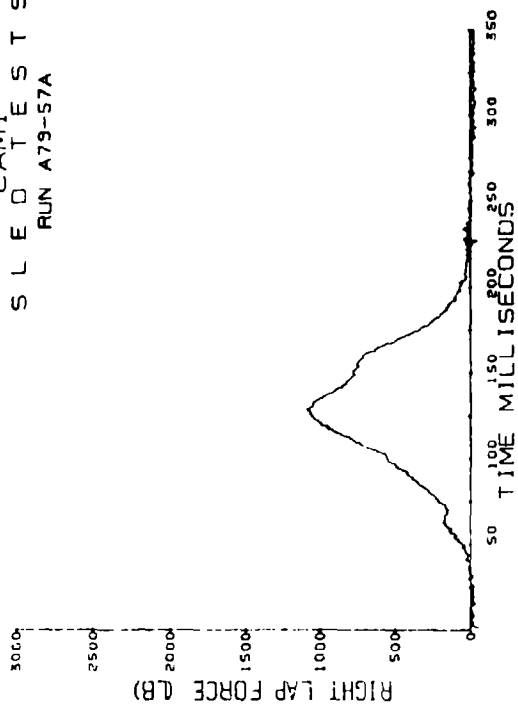
CAMI S L E D T E S T S RUN A79-56C



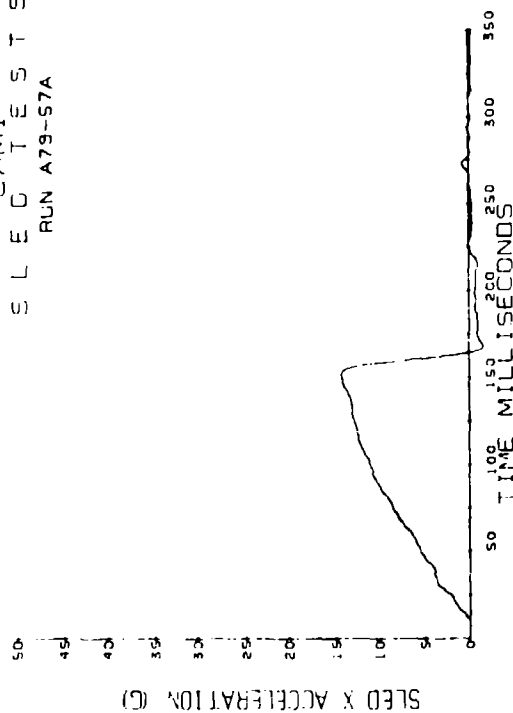
CAMI S L E D T E S T S RUN A79-56C



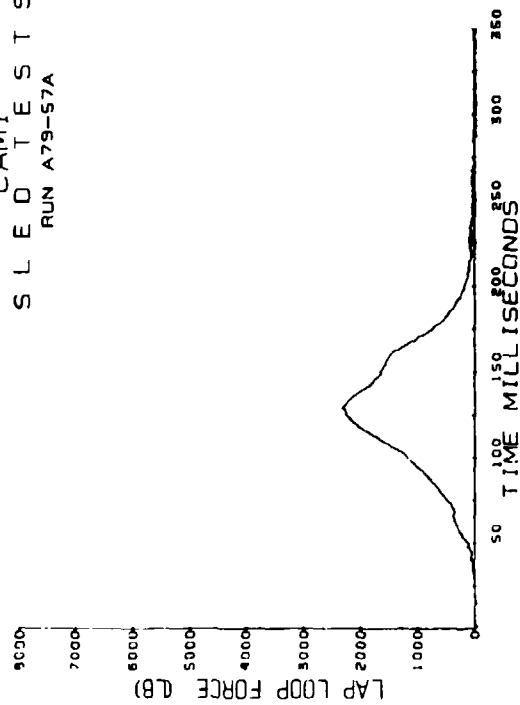
CAMI
S L E D T E S T S
RUN A79-57A



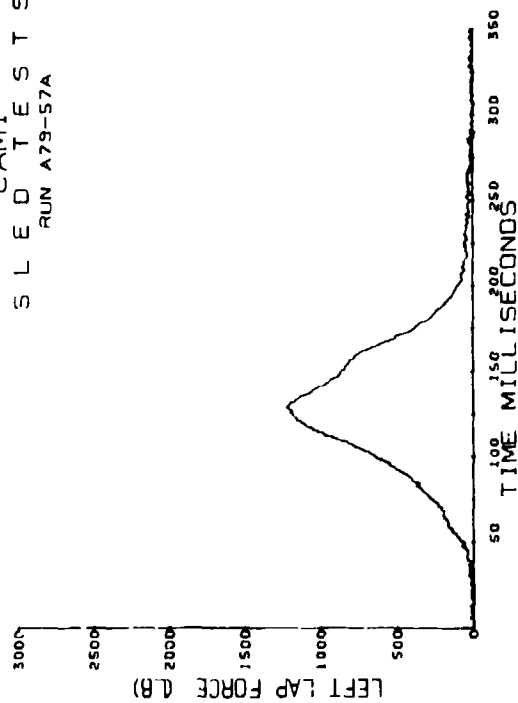
CAMI
S L E D T E S T S
RUN A79-57A



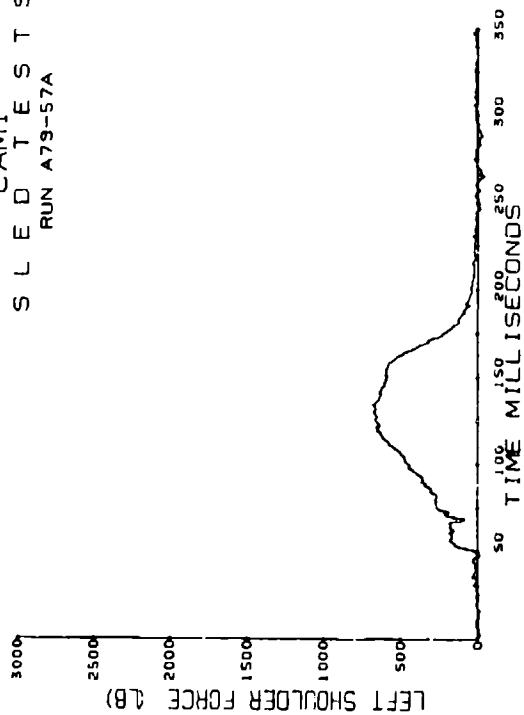
CAMI
S L E D T E S T S
RUN A79-57A



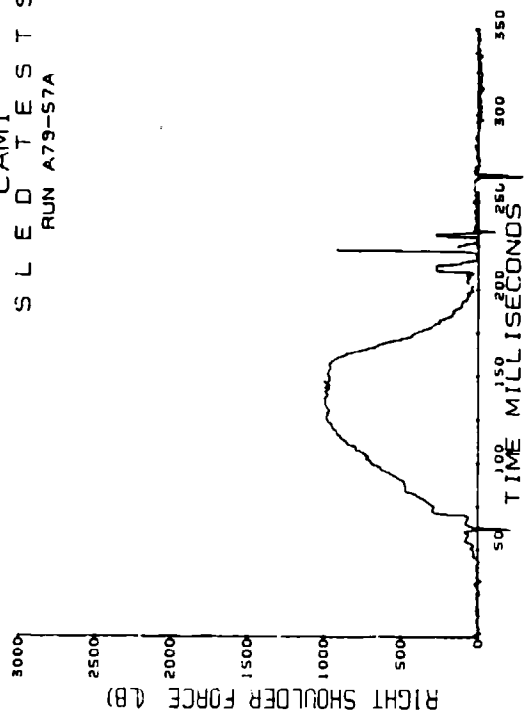
CAMI
S L E D T E S T S
RUN A79-57A



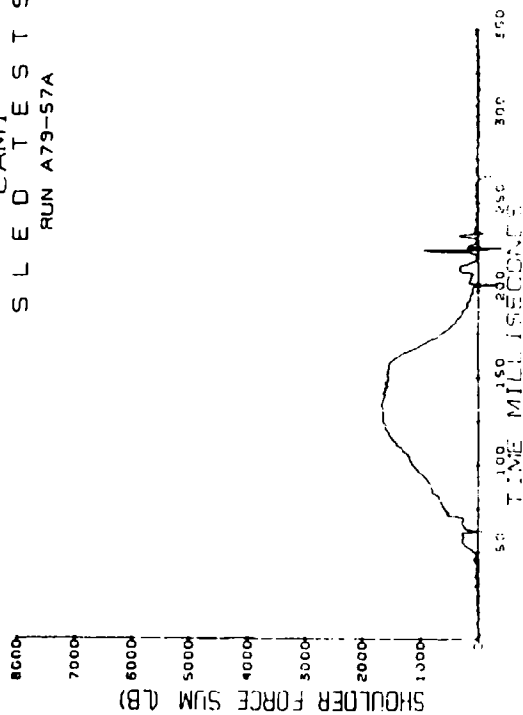
CAMI
S L E D T E S T S
RUN A79-57A

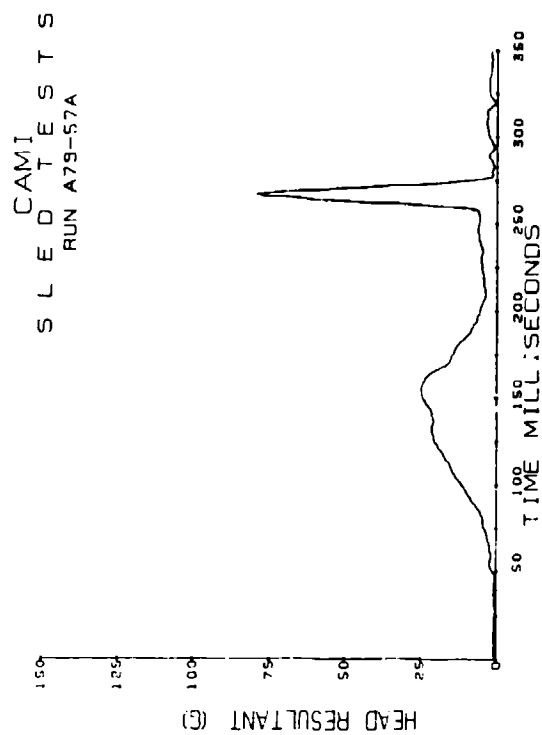
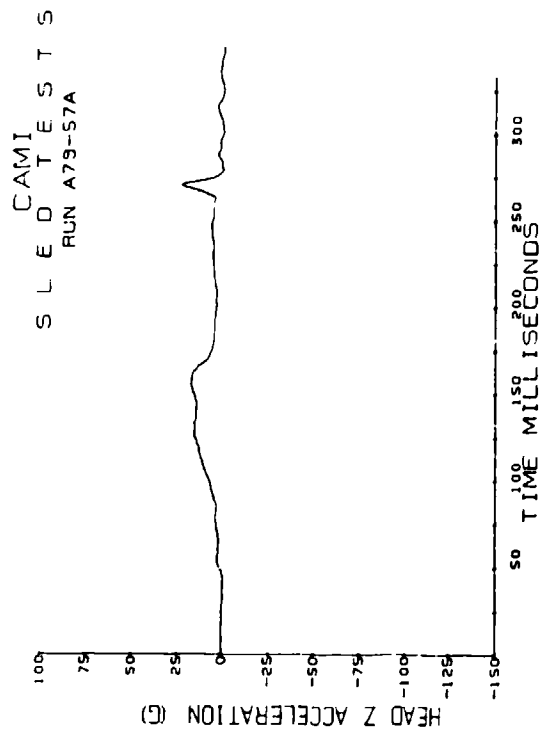
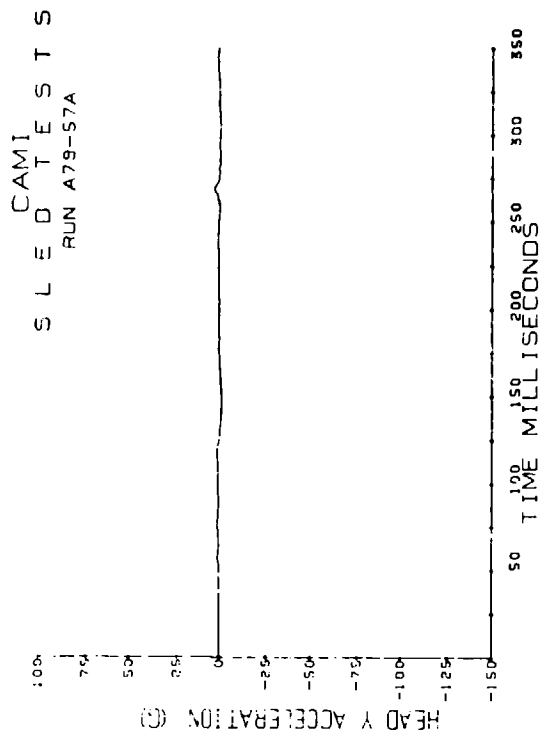
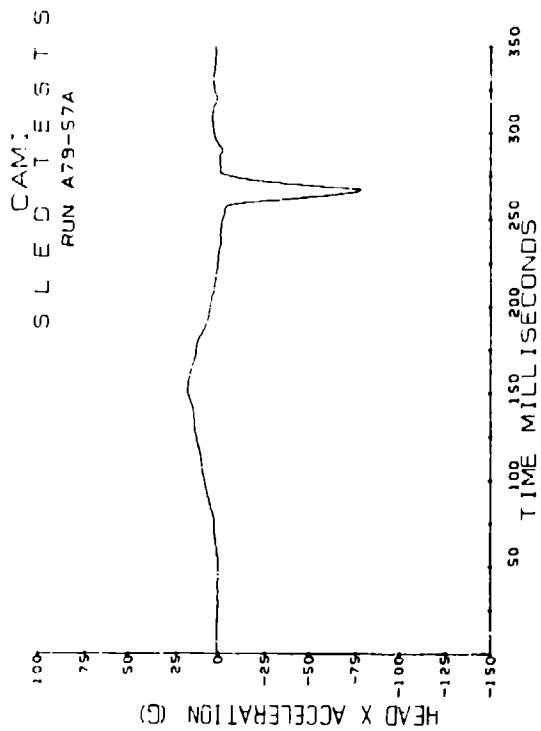


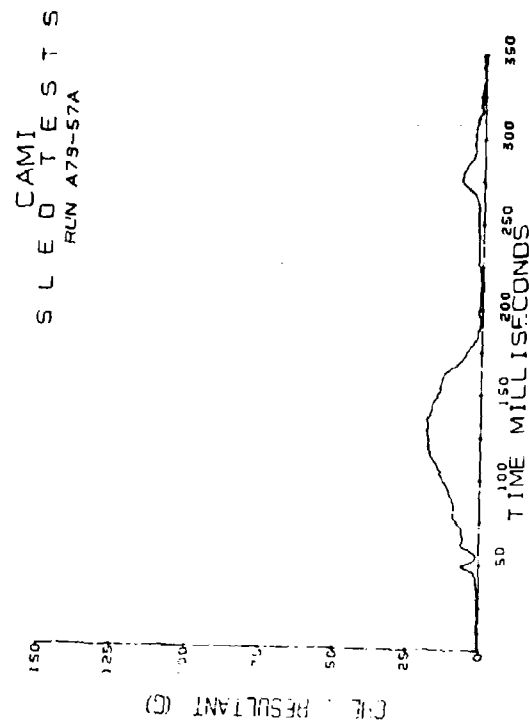
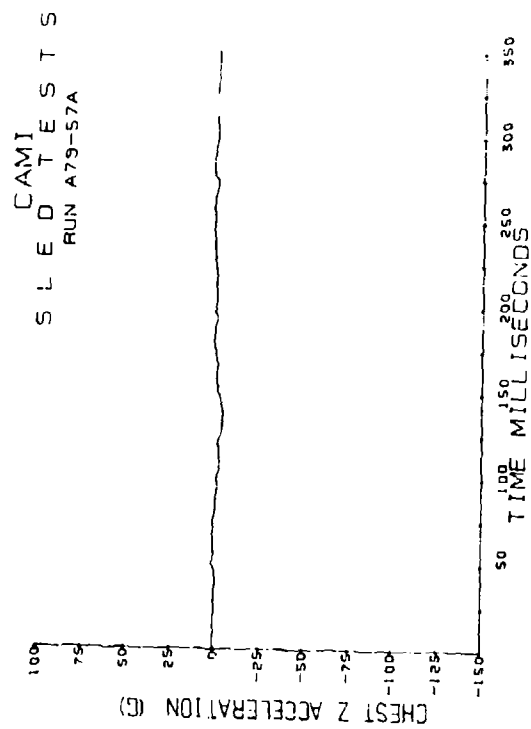
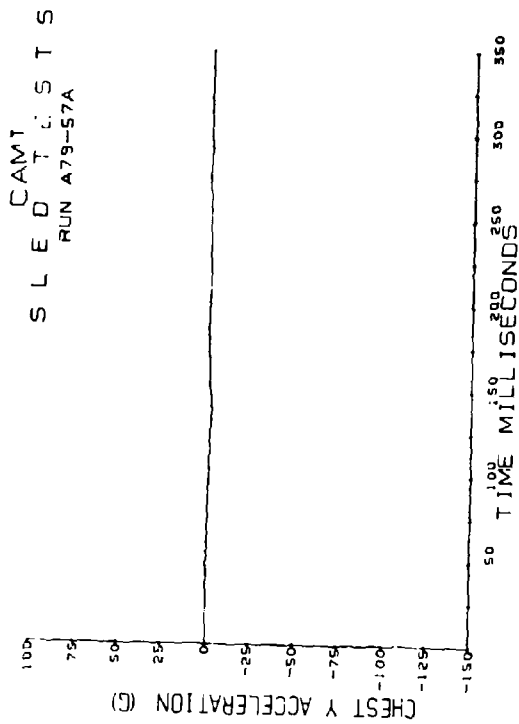
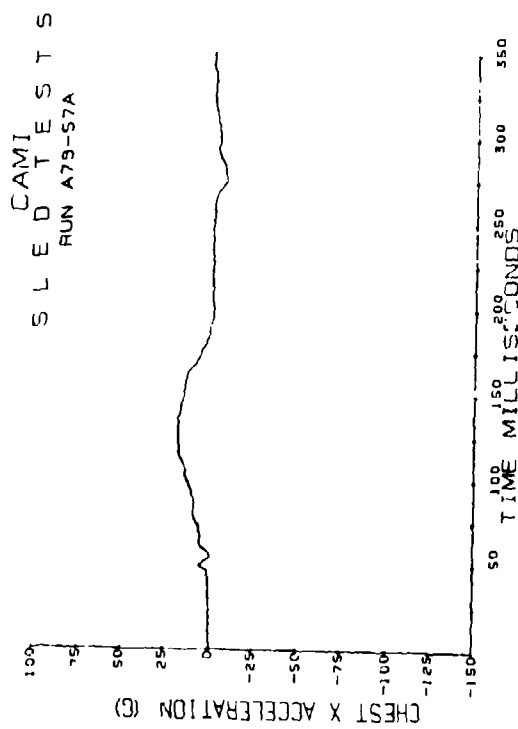
CAMI
S L E D T E S T S
RUN A79-57A



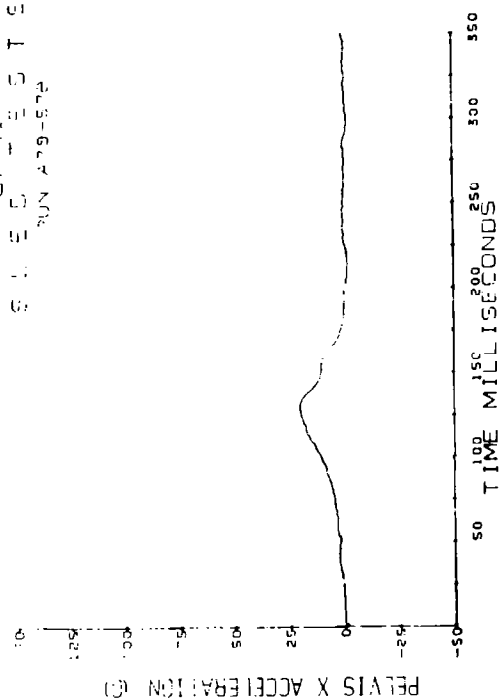
CAMI
S L E D T E S T S
RUN A79-57A



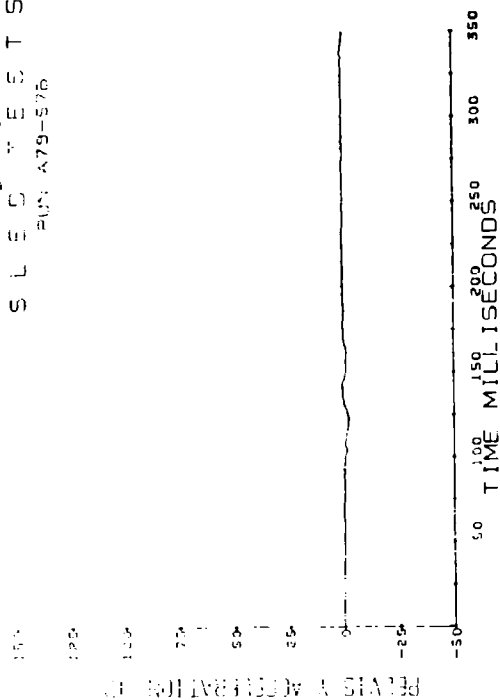




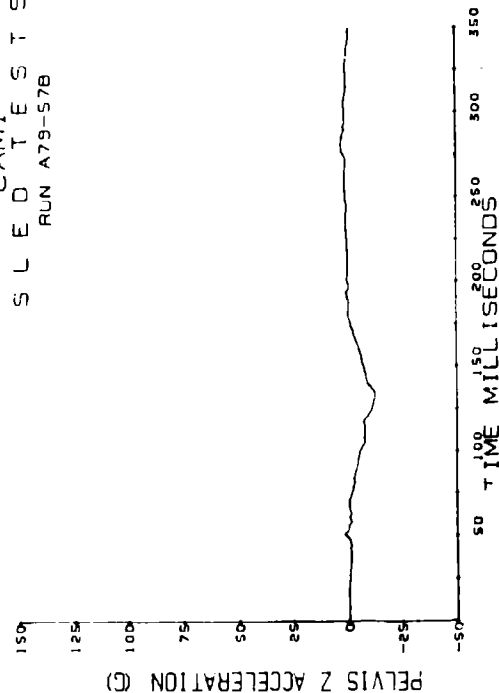
CAMI
S L E D T E S T S
RUN A79-572



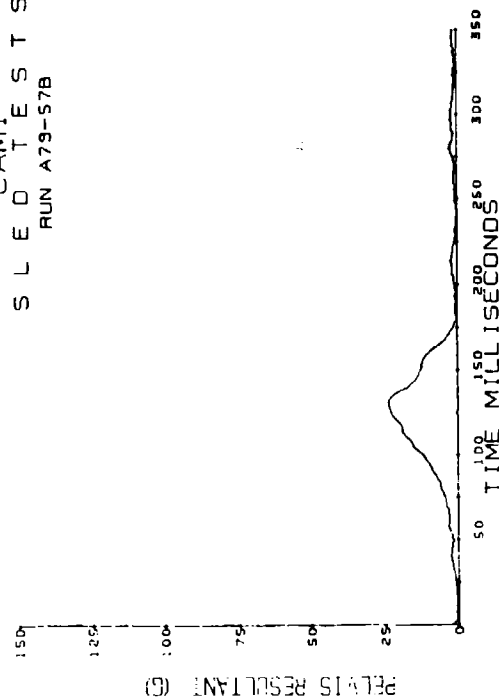
CAMI
S L E D T E S T S
RUN A79-57B



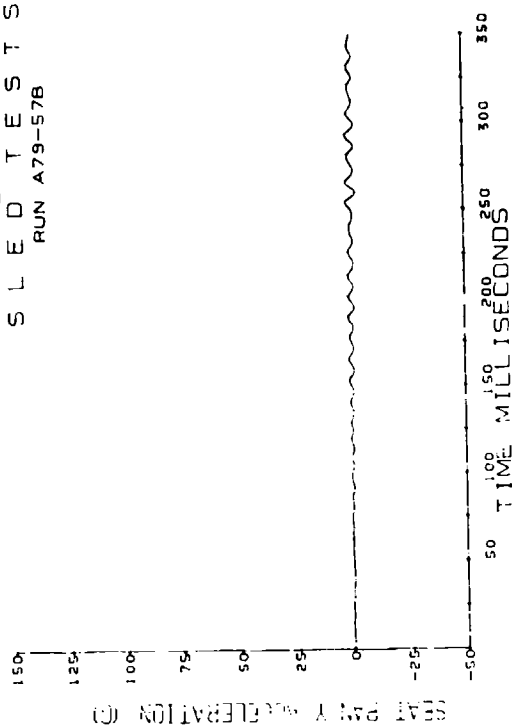
CAMI
S L E D T E S T S
RUN A79-57B



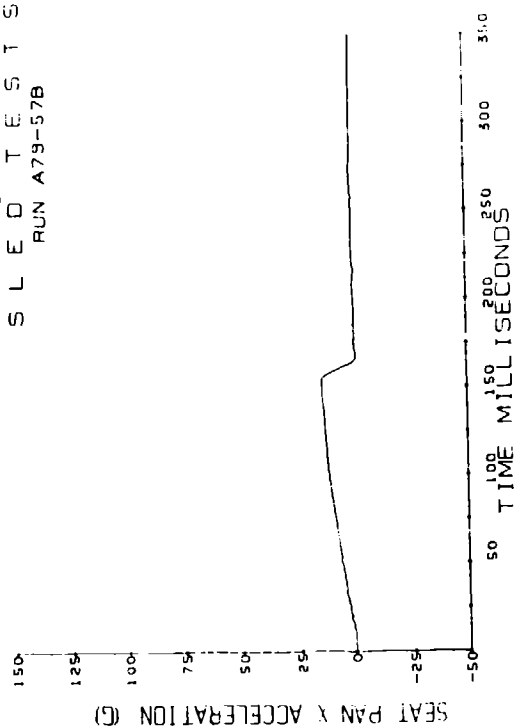
CAMI
S L E D T E S T S
RUN A79-57B



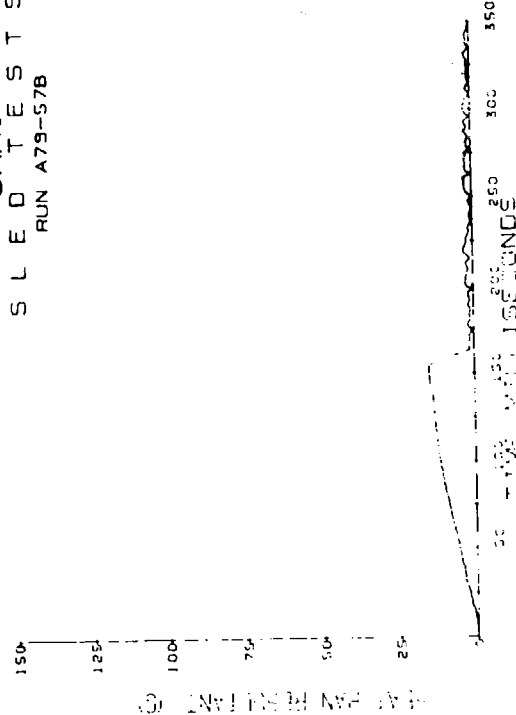
CAMI
S L E D T E S T S
RUN A79-57B



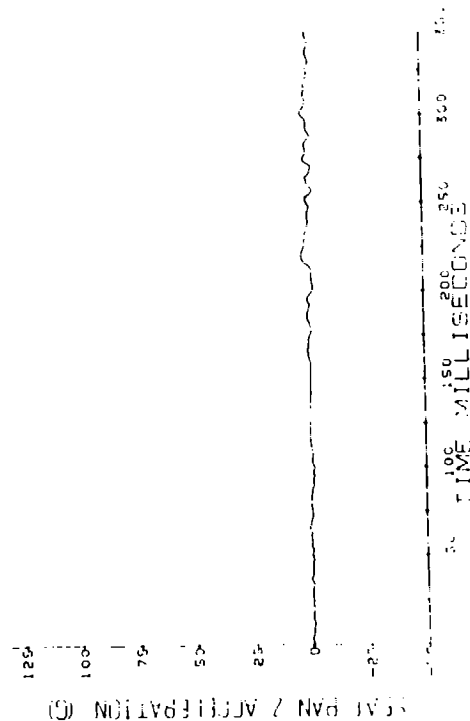
CAMI
S L E D T E S T S
RUN A79-57B



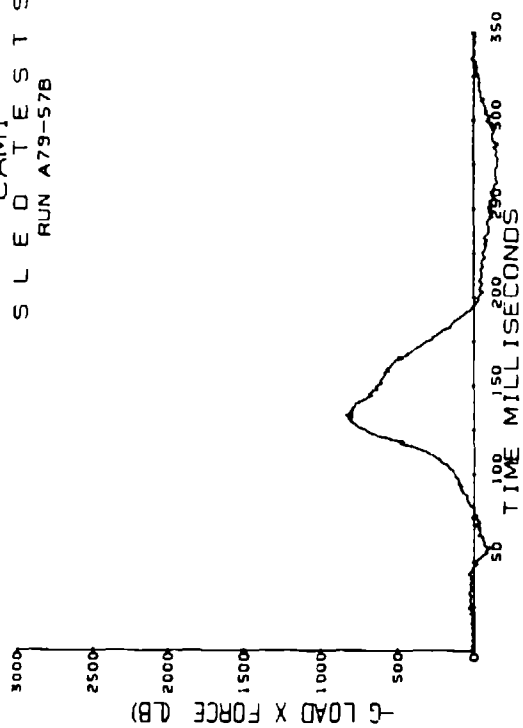
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S L E D T E S T S
RUN A79-57B



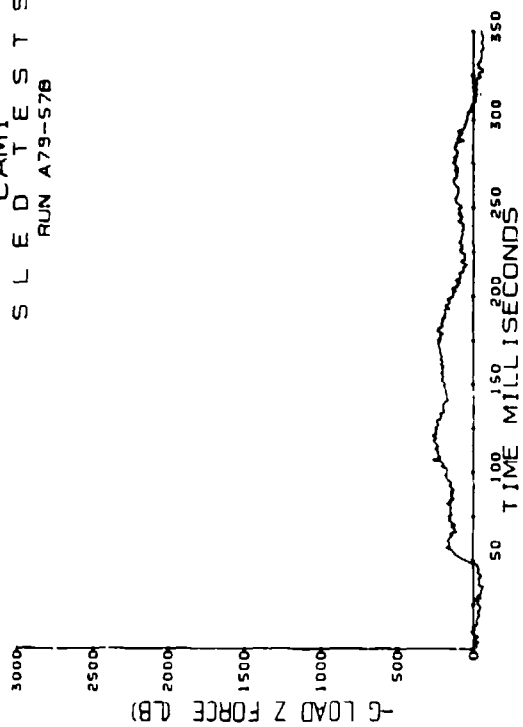
CAMI
S L E D T E S T S
RUN A79-57B



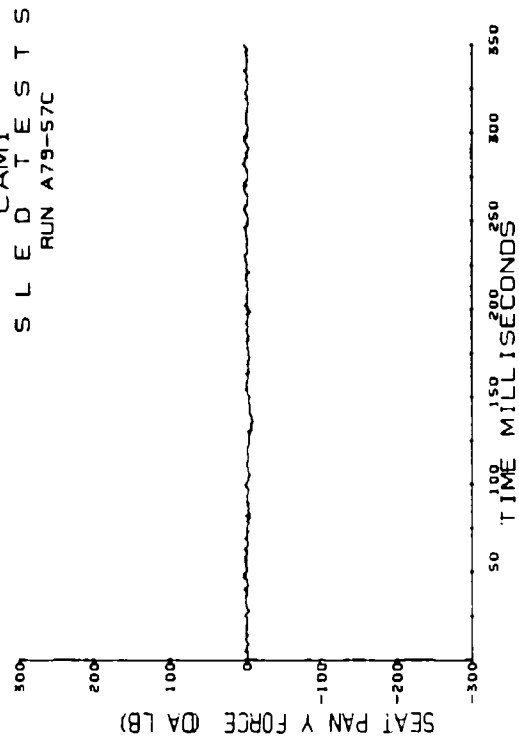
CAMI
S L E D T E S T S
RUN A79-57B



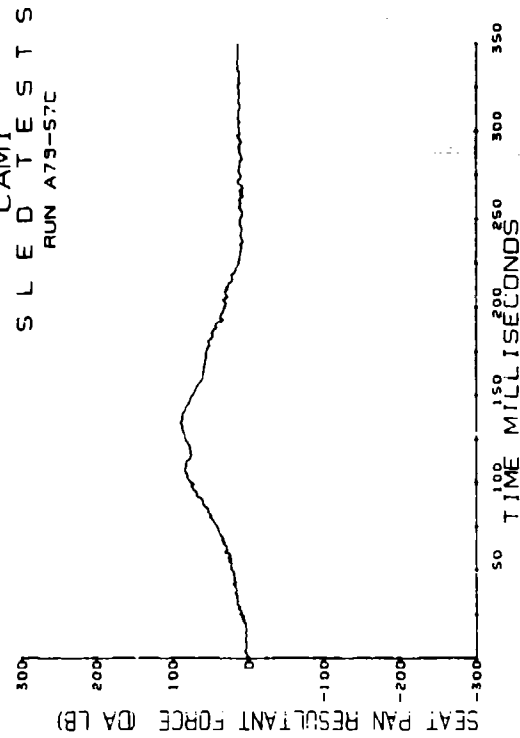
CAMI
S L E D T E S T S
RUN A79-57B



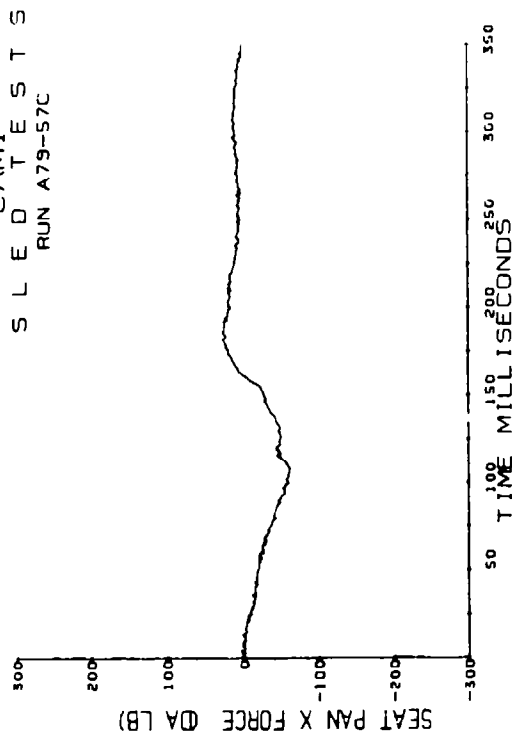
CAMI
S L E D T E S T S
RUN A79-57C



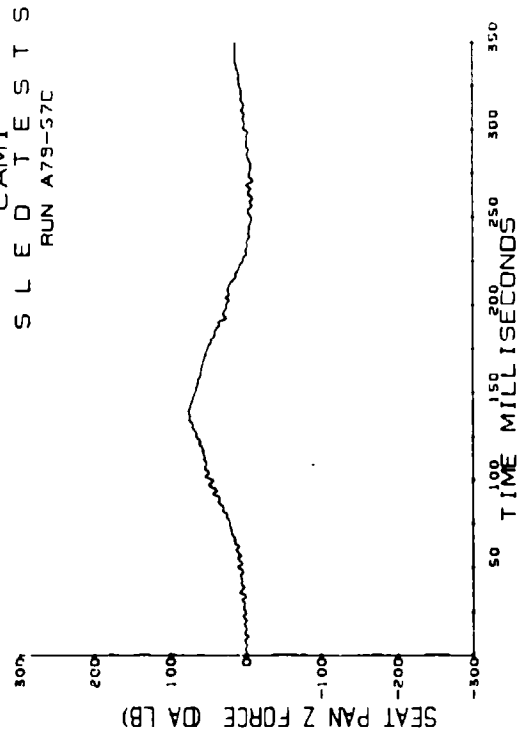
CAMI
S L E D T E S T S
RUN A79-57C



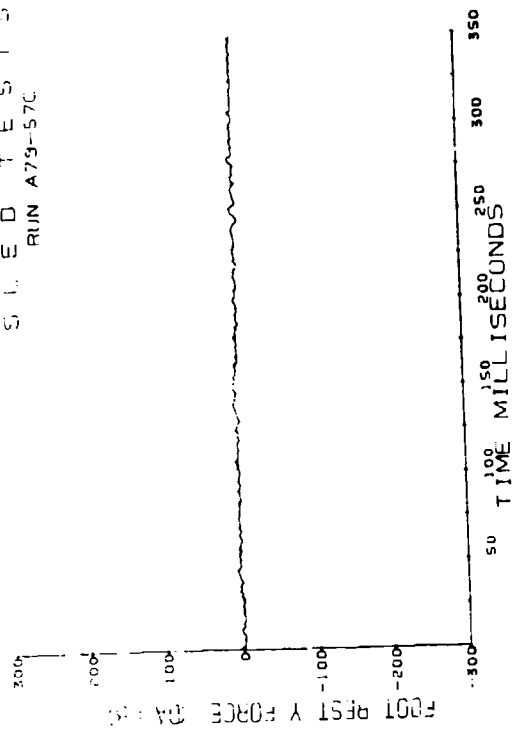
CAMI
S L E D T E S T S
RUN A79-57C



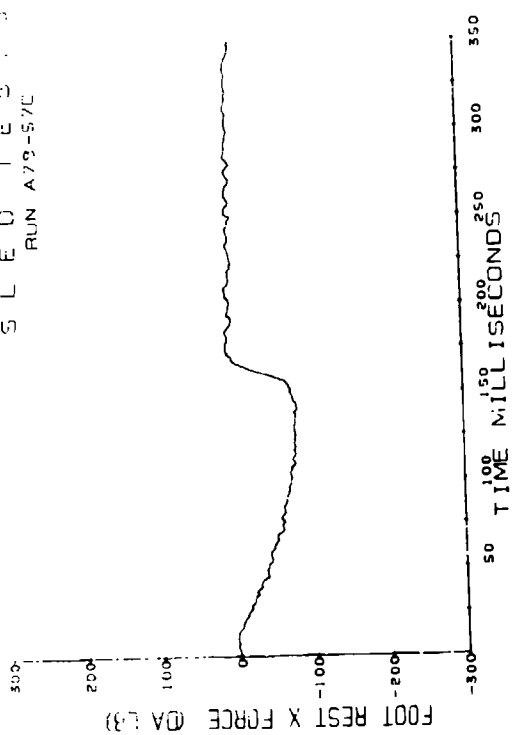
CAMI
S L E D T E S T S
RUN A79-57C



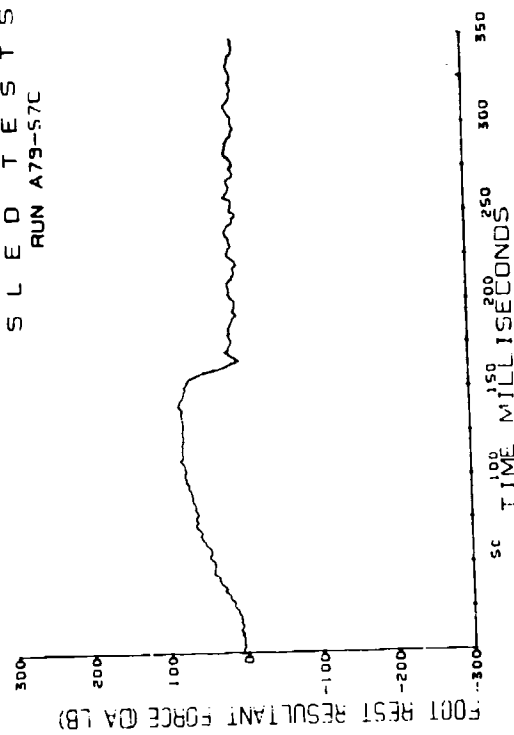
CAMI
S L E D T E S T S
RUN A79-57C



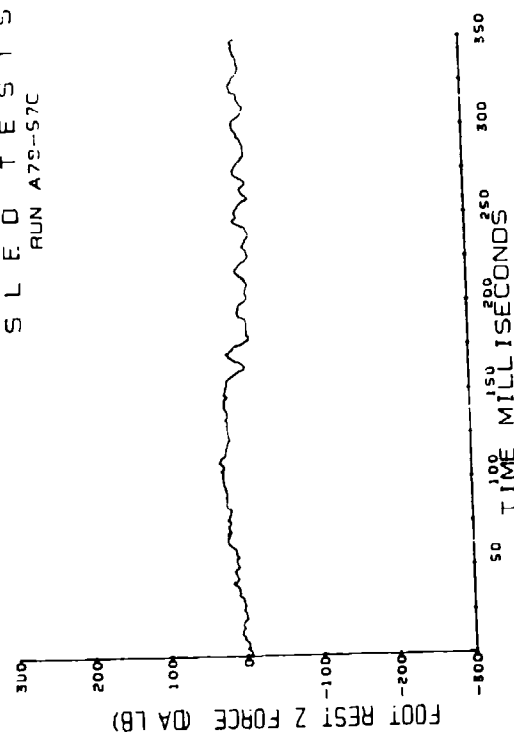
CAMI
S L E D T E S T S
RUN A79-57C



CAMI
S L E D T E S T S
RUN A79-57C



CAMI
S L E D T E S T S
RUN A79-57C



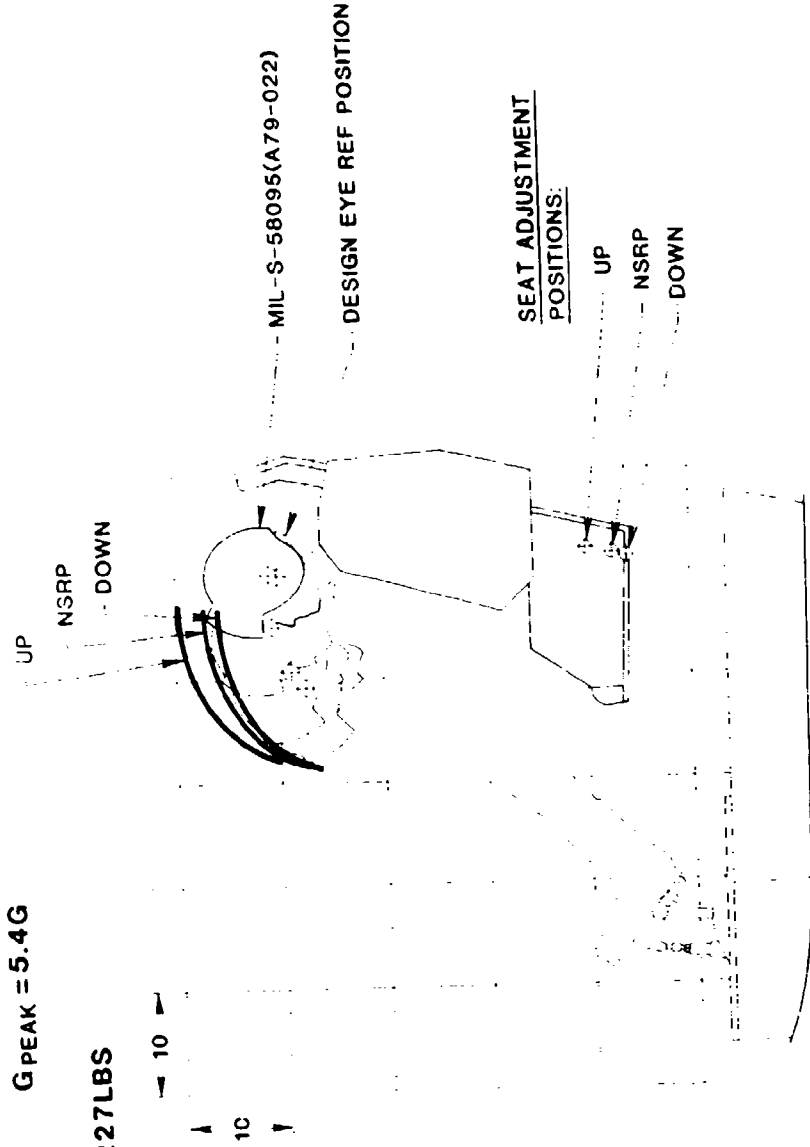
APPENDIX B
ANTHROPOMORPHIC DUMMY STRIKE ENVELOPES

PULSE: 50th PERCENTILE SURVIVABLE

$\Delta V = 28 \text{ FPS}$ $G_{\text{PEAK}} = 5.4 \text{ G}$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227 LBS



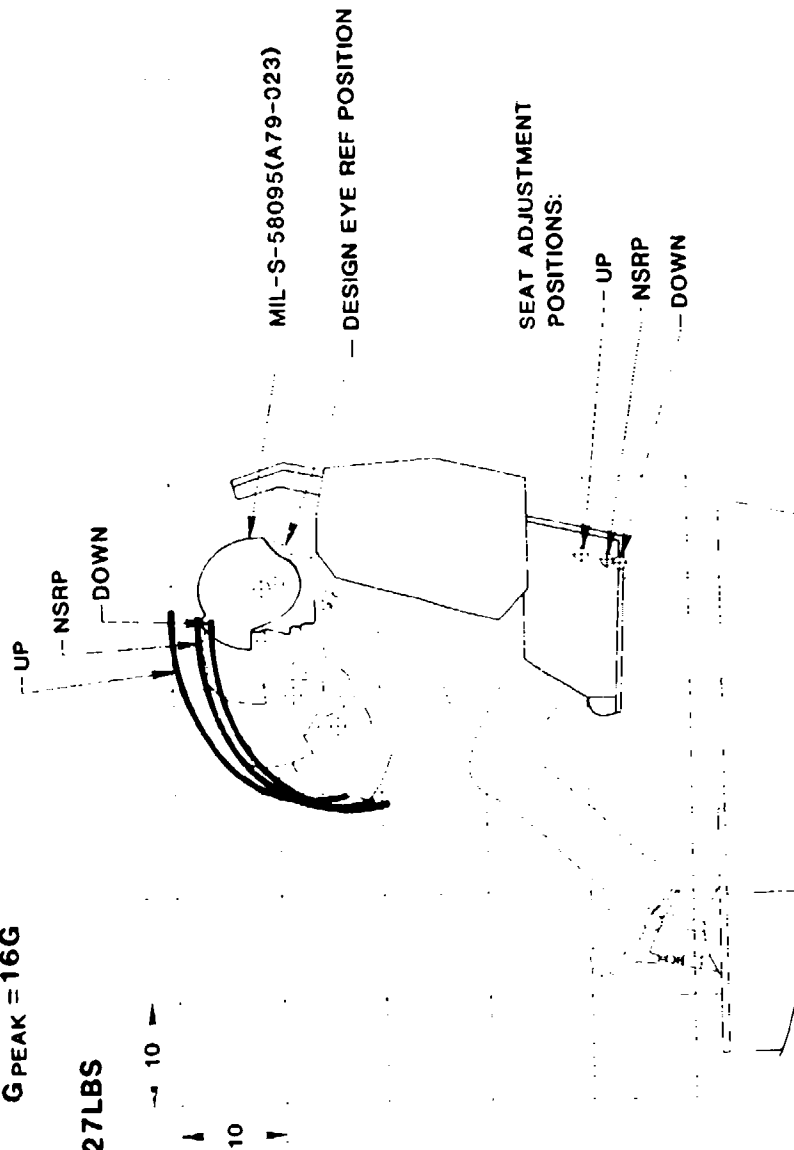
CPG STRIKE ENVELOPE

PULSE: 85th PERCENTILE SURVIVABLE

$\Delta V = 39\text{FPS}$ $G_{\text{PEAK}} = 16G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



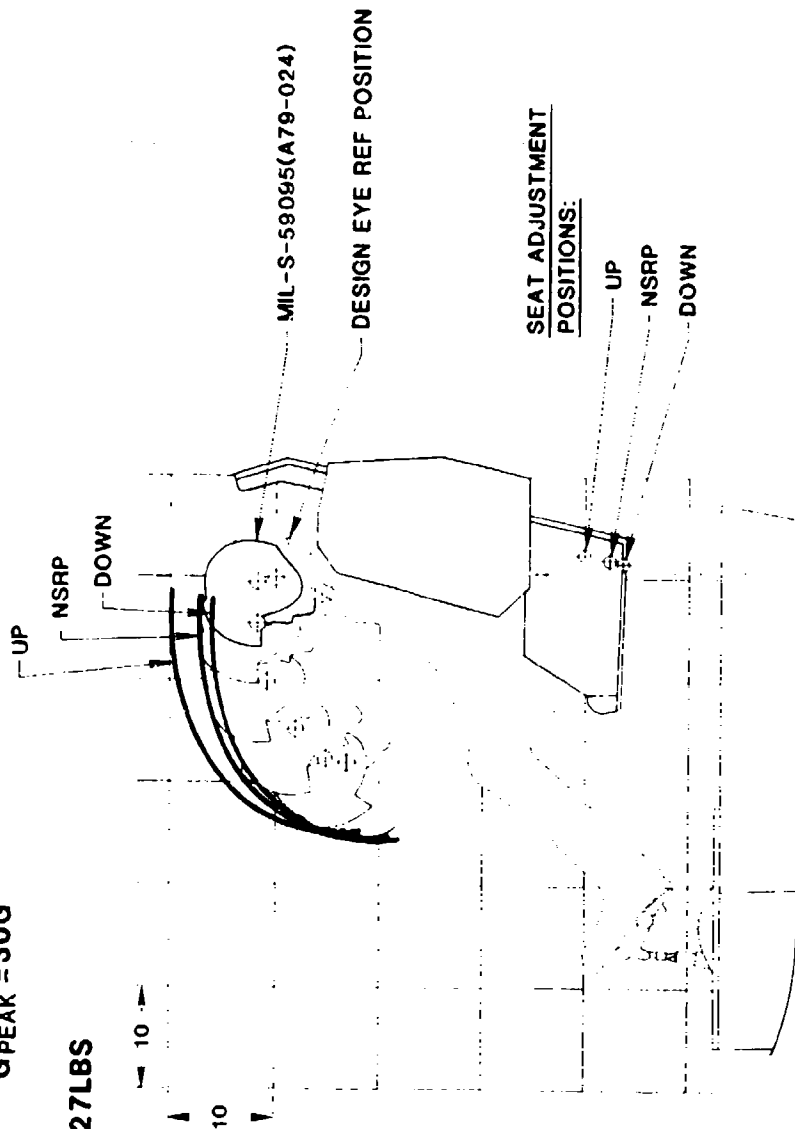
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50\text{FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



CPG STRIKE ENVELOPE

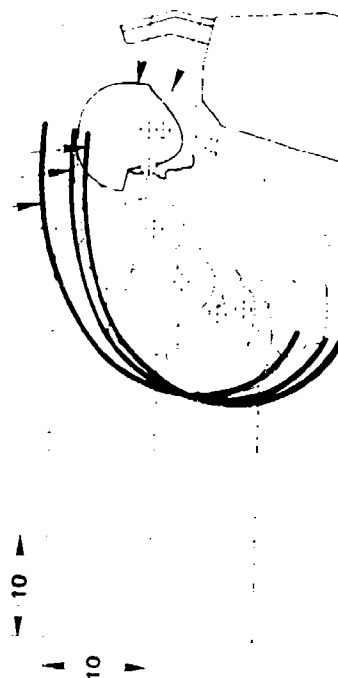
PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS

UP
--NSRP
DOWN



MIL-S-58095(A79-026)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

UP
NSRP
DOWN

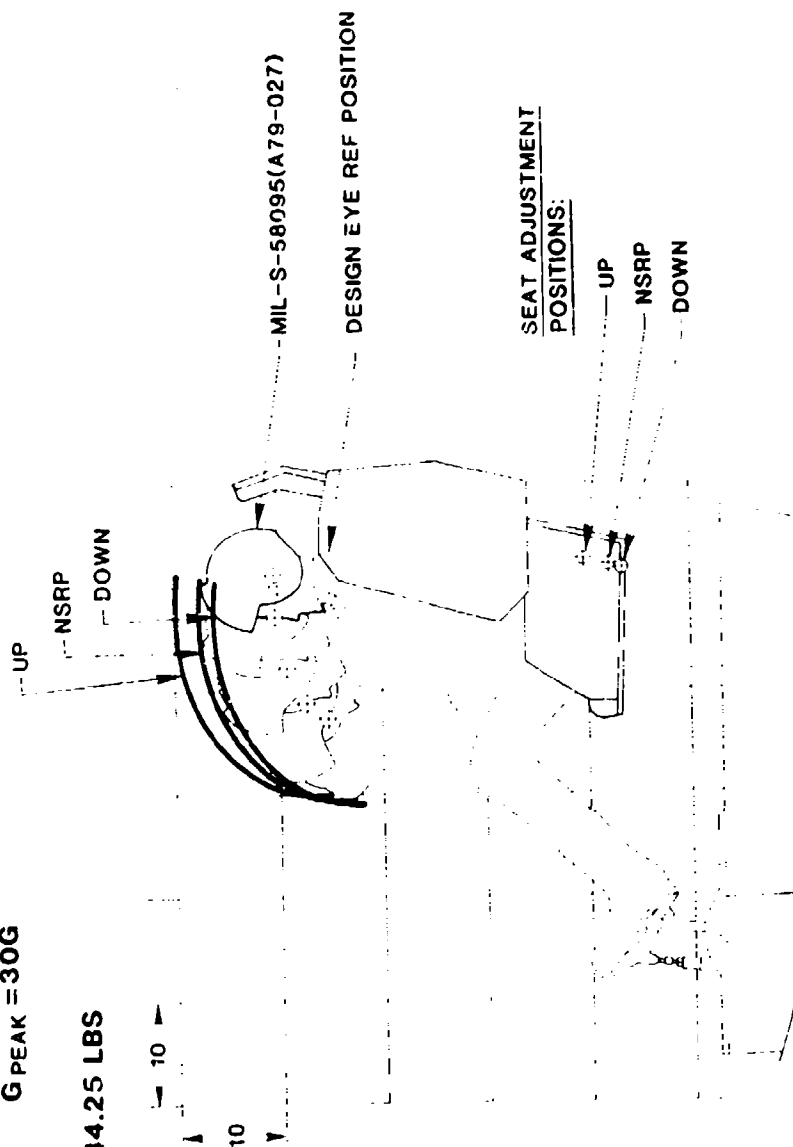
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 244.25 LBS



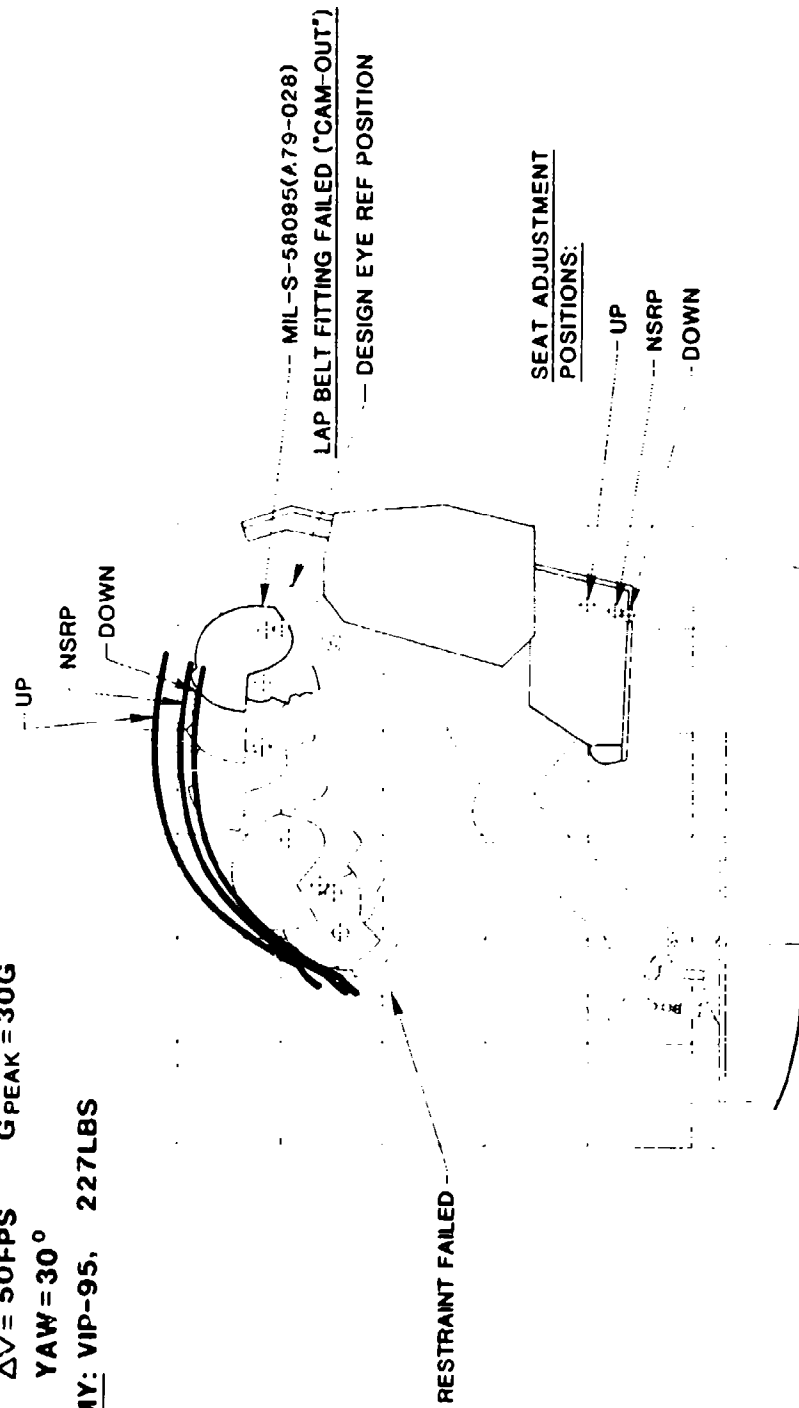
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30 \text{ G}$

YAW = 30°

DUMMY: VIP-95, 227LBS



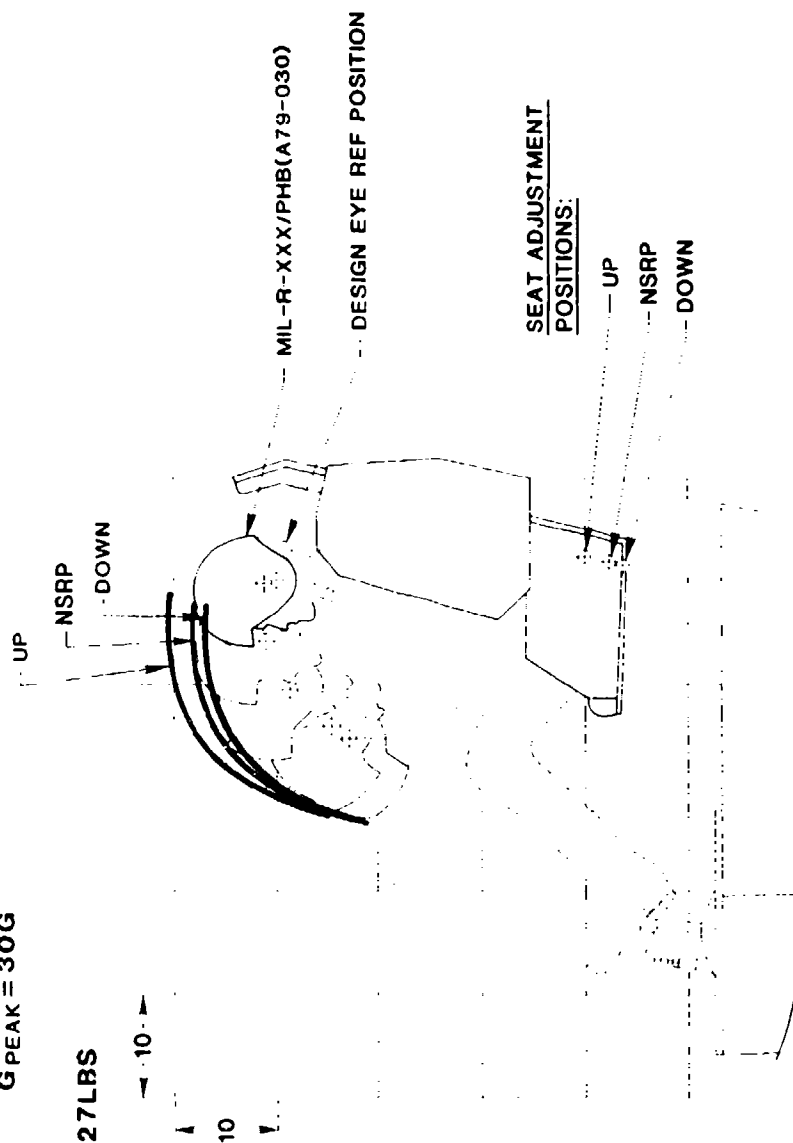
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50\text{FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



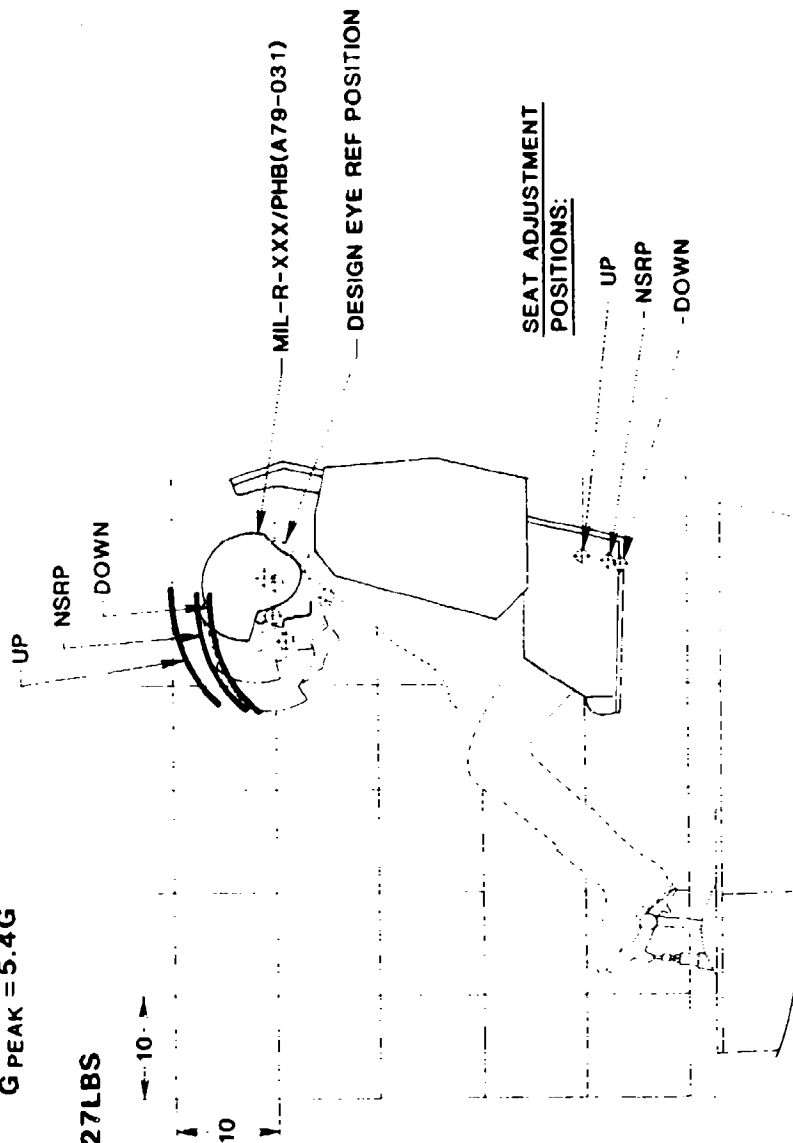
CPG STRIKE ENVELOPE

PULSE: 50th PERCENTILE SURVIVABLE

$\Delta V = 28 \text{ FPS}$ $G_{\text{PEAK}} = 5.4 G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS



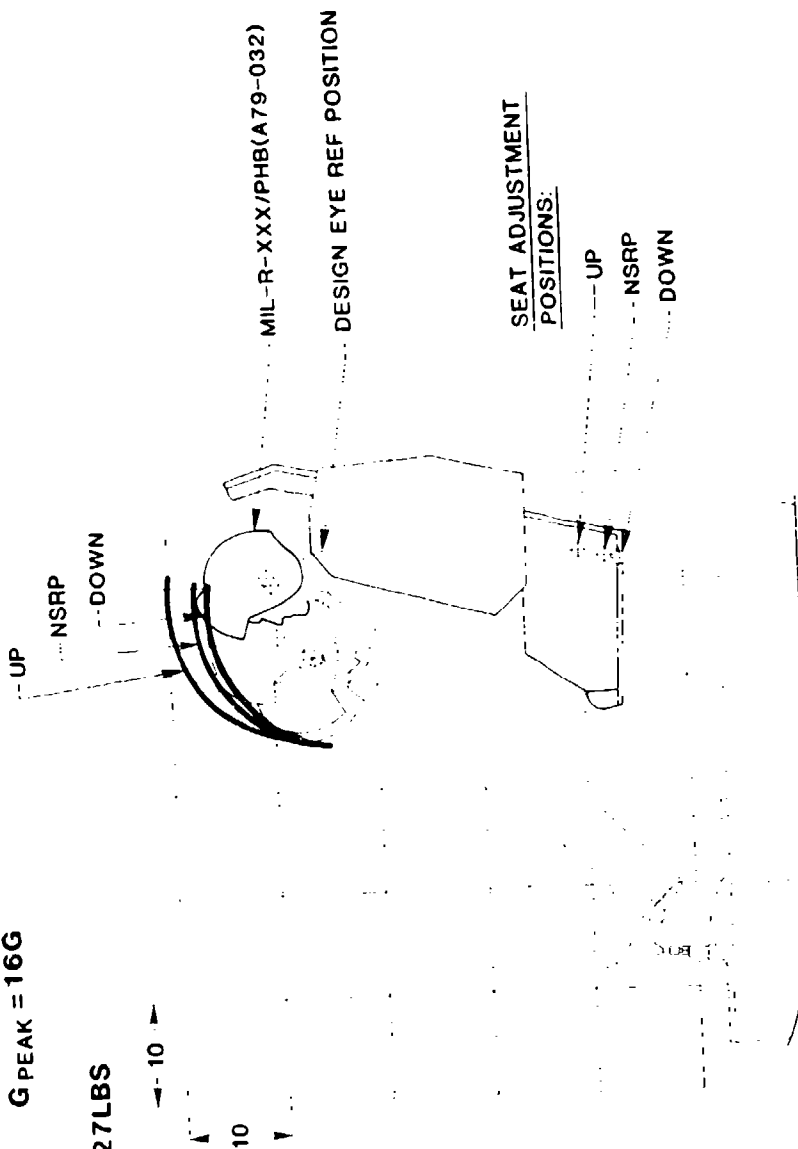
CPG STRIKE ENVELOPE

PULSE: 85th PERCENTILE SURVIVABLE

$\Delta V = 39\text{FPS}$ $G_{\text{PEAK}} = 16G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



CPG STRIKE ENVELOPE

PULSE: 25th PERCENTILE SURVIVABLE

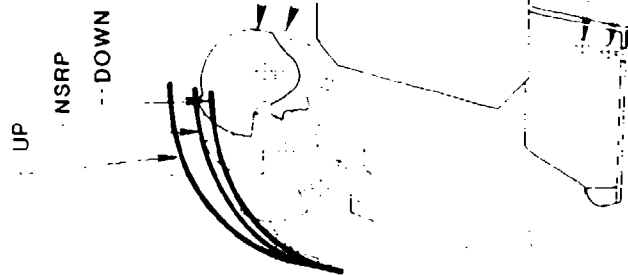
$\Delta V = 39 \text{ FPS}$ $G_{\text{PEAK}} = 16G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS

$\rightarrow -10^\circ$

10



MIL-R-XXX/PHB(A79-033)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

— UP
-- NSRP
... DOWN

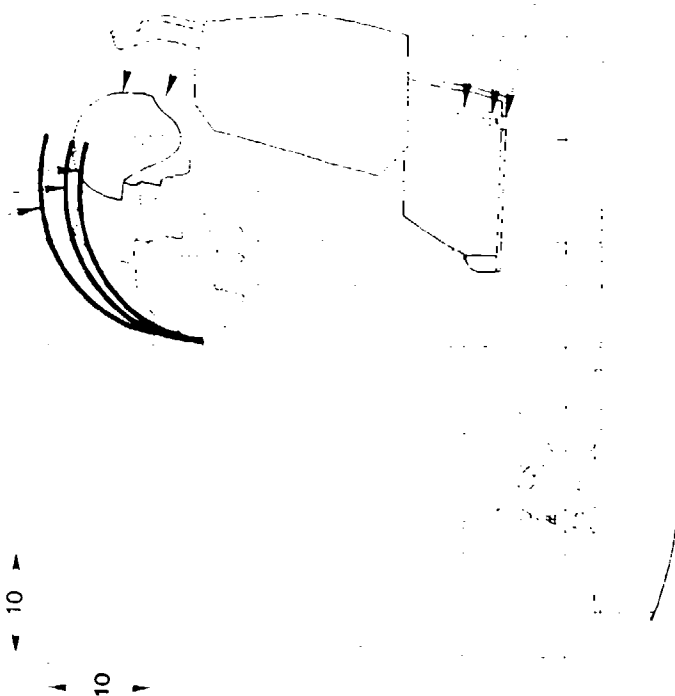
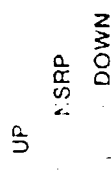
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$$\Delta V = 50 \text{ FPS} \quad G_{\text{PEAK}} = 30 \text{ G}$$

YAW=0°

DUMMY: VIP-95, 244.25LBS



MIL-R-XXX/PHB(A79-034)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

- UP
NSRP
DOWN

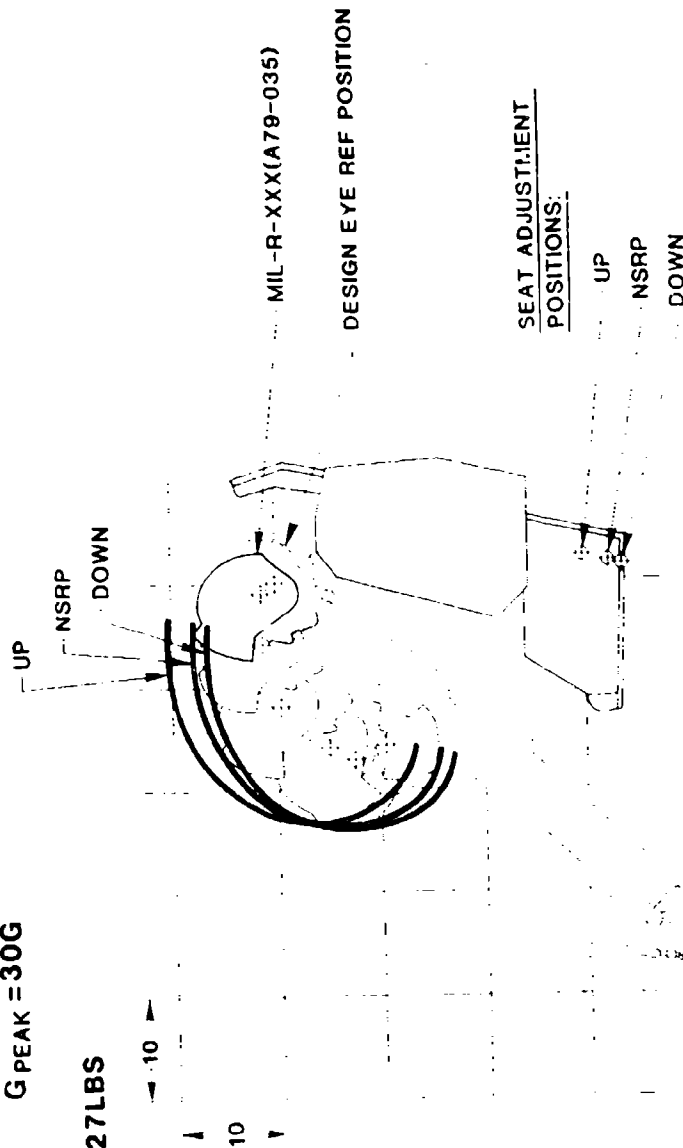
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS



SEAT ADJUSTMENT
POSITIONS:

UP
NSRP
DOWN

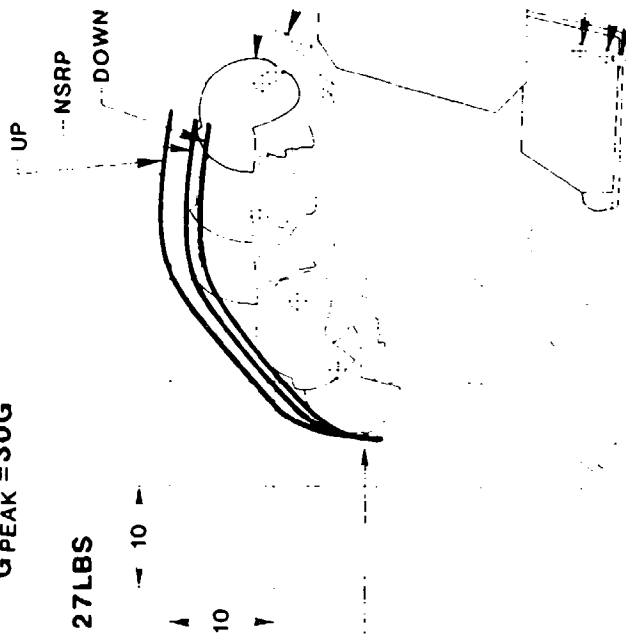
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50\text{FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 30^\circ$

DUMMY: VIP-95, 227LBS



MIL-S-58095(A79-036)

FAILED

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

— UP

--- NSRP

DOWN

CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS

NSRP



MIL-S-58085(A798-036)

FAILED

DESIGN EYE REF POSITION

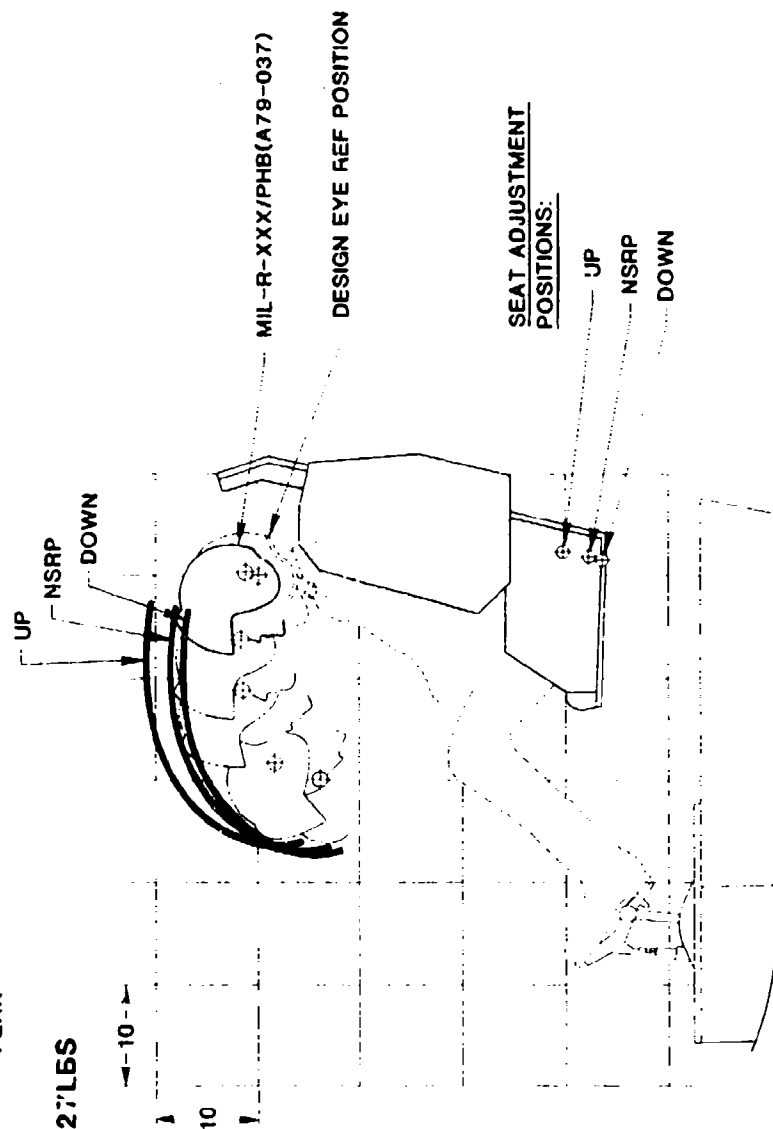
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227L5S



CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS

NSRP

10

10



—MIL-R-XXX/PHB(A79-037)

—DESIGN EYE REF POSITION

CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

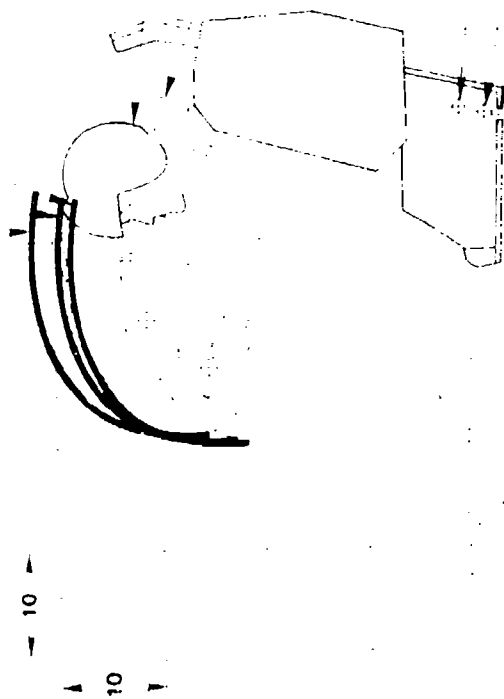
$YAW = 30^\circ$

DUMMY: VIP-95, 227LBS

UP

NSRP

DOWN



MIL-R-XXX(A79-039)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

UP

NSRP

DOWN

CPG STRIKE ENVELOPE

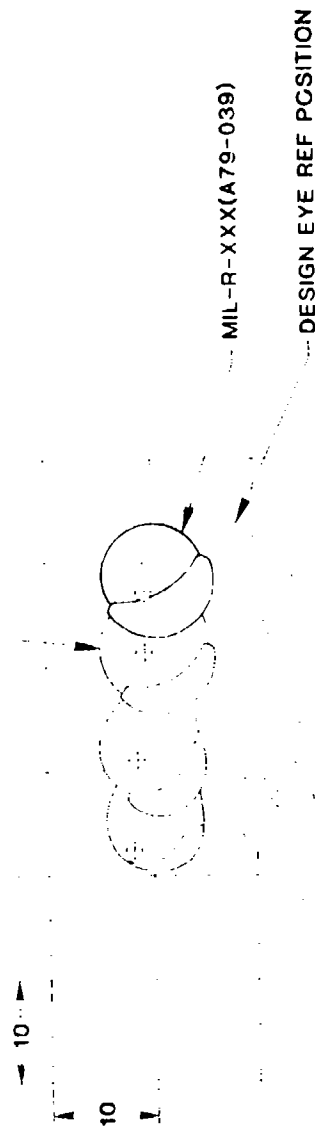
PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS

NSRP



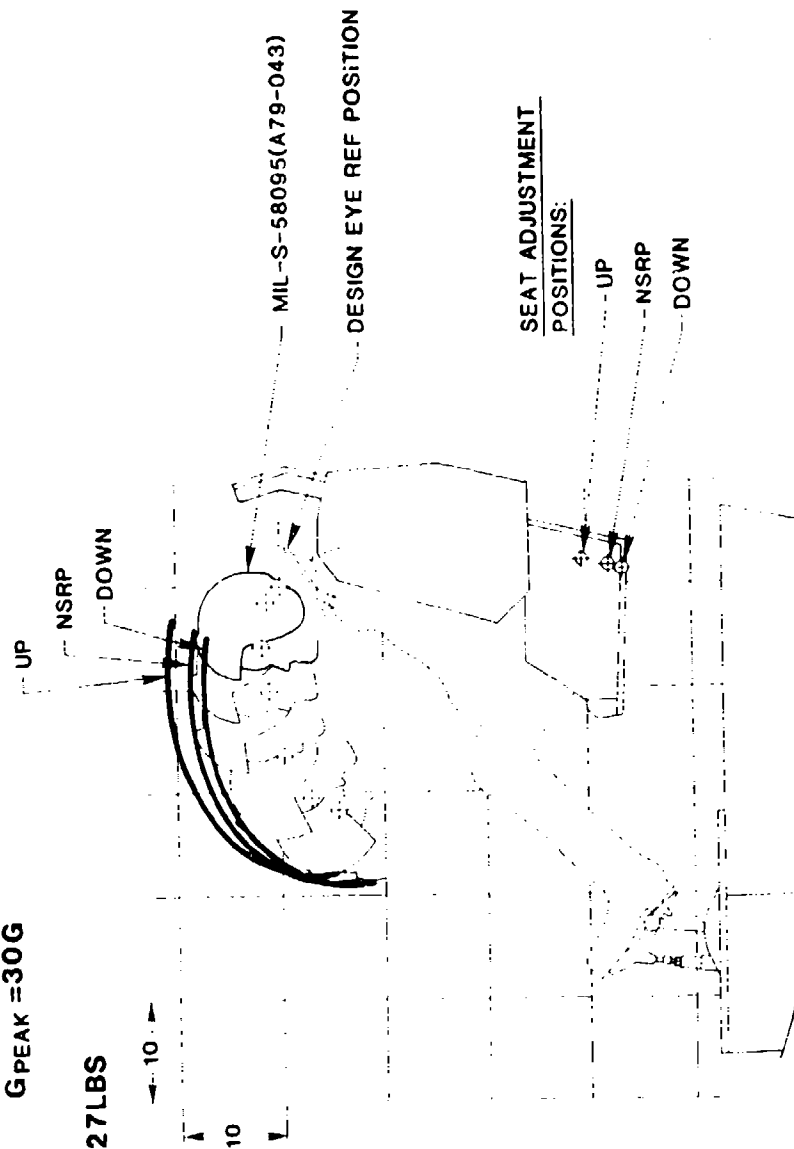
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} \approx 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



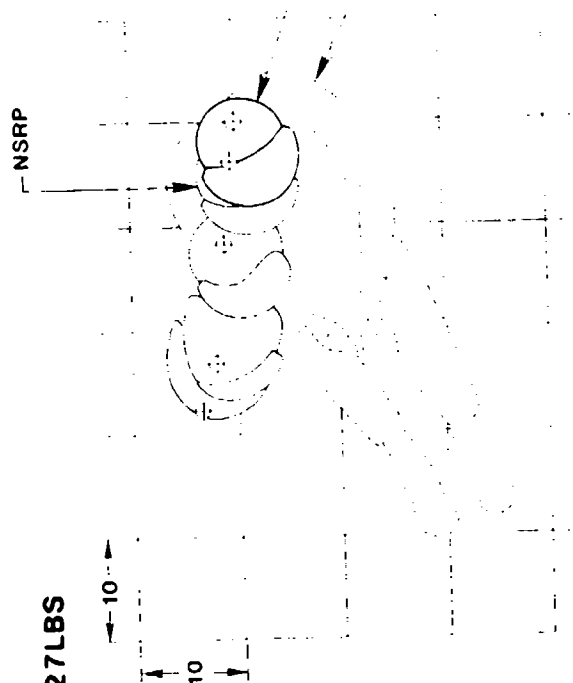
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



MIL-S-58095(A79-043)

- DESIGN EYE REF POSITION

CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 30^\circ$

DUMMY: VIP-95, 227LBS

UP
NSRP
DOWN

10

10

MIL-S-58095(A79-044)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

UP
NSRP
DOWN

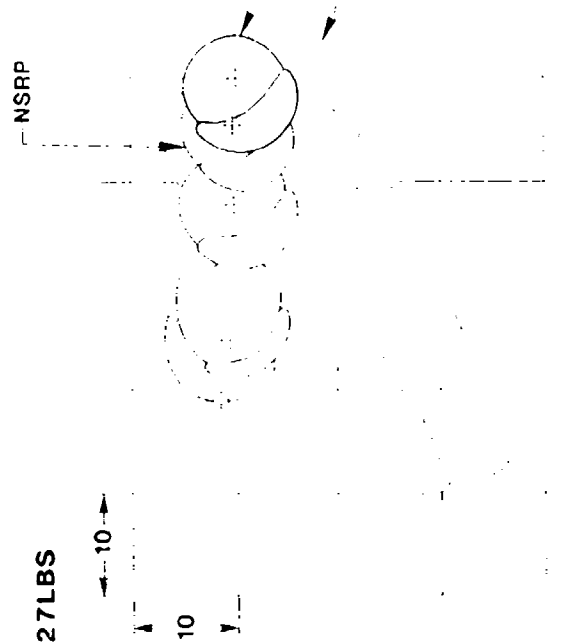
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



-- MIL-S-58095(A79-044)

-- DESIGN EYE REF POSITION

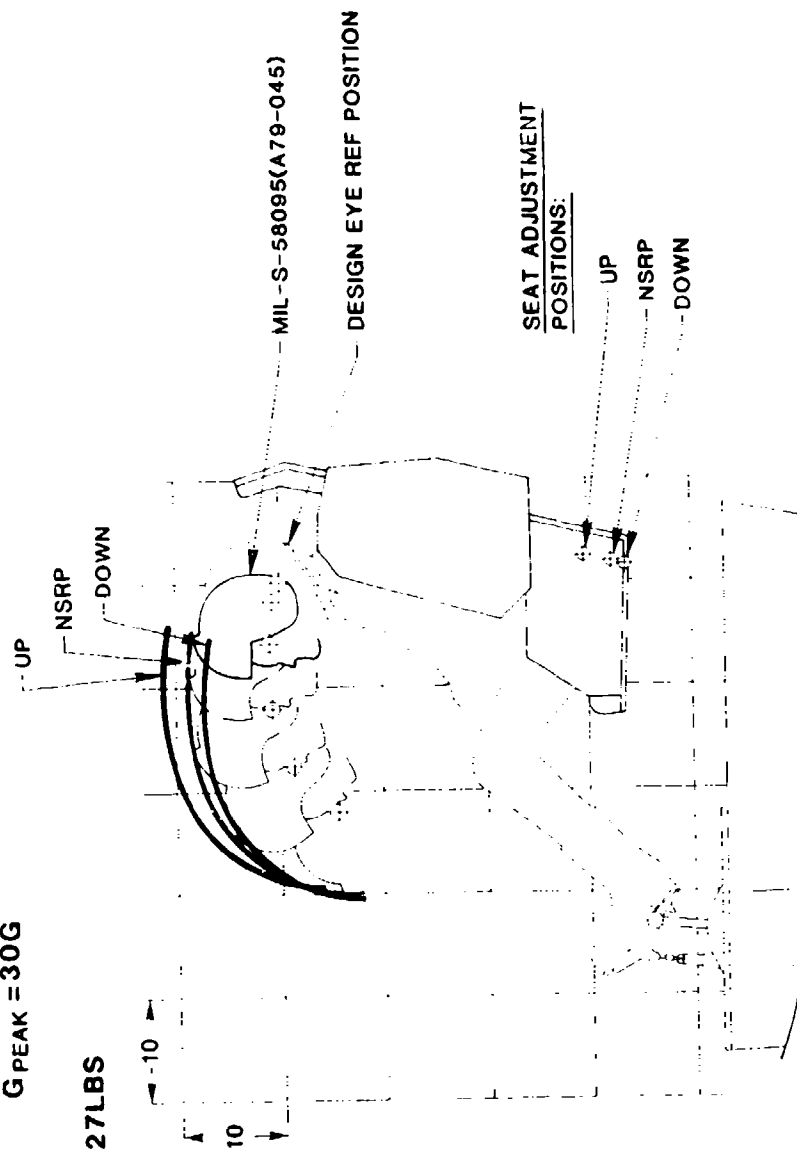
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



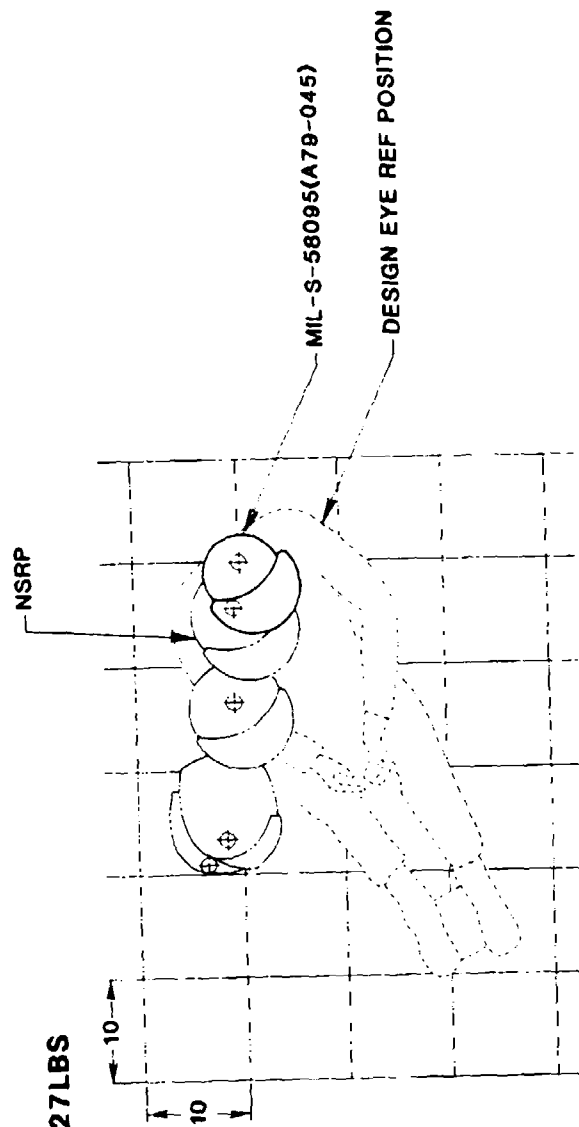
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



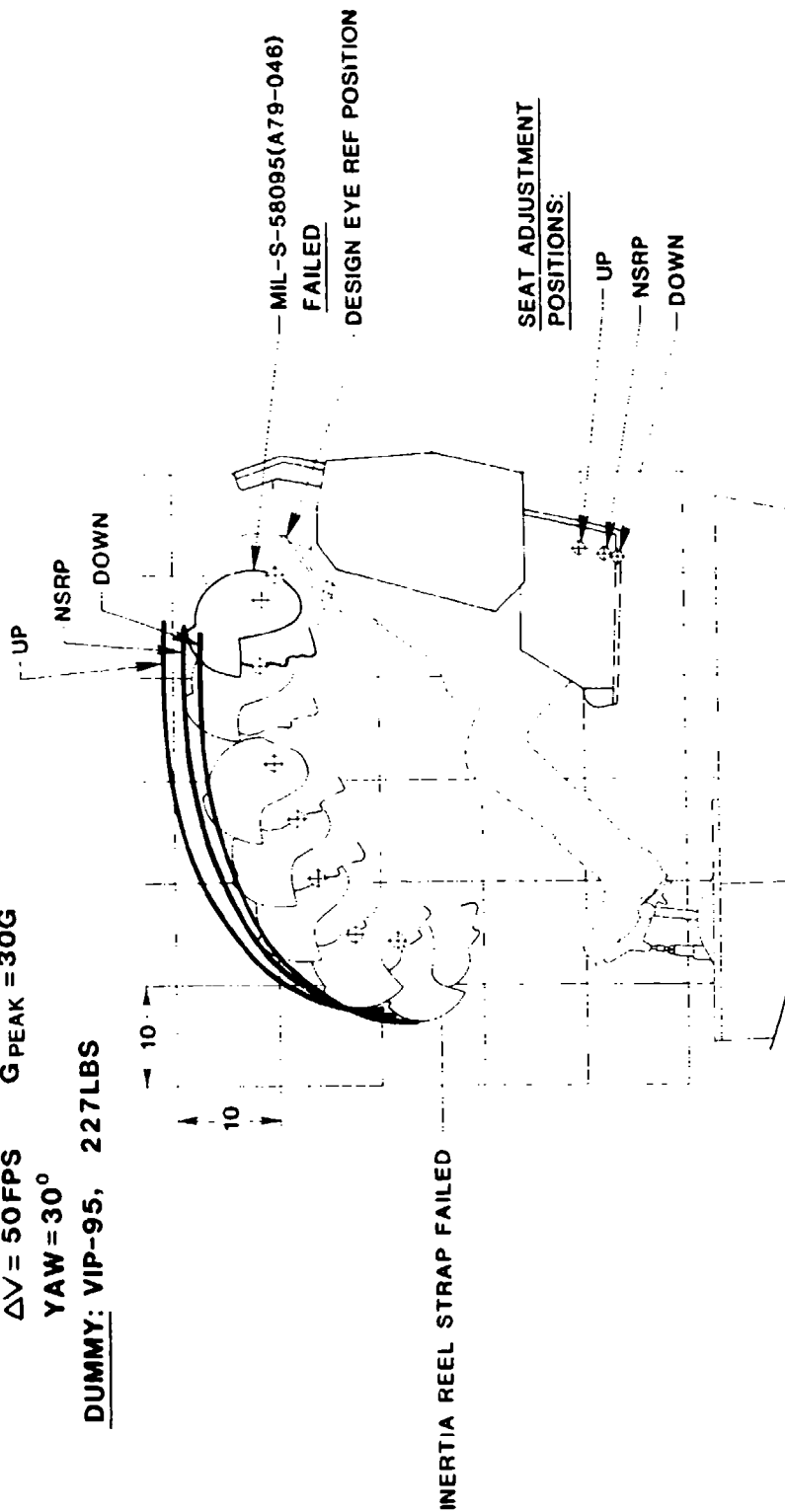
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



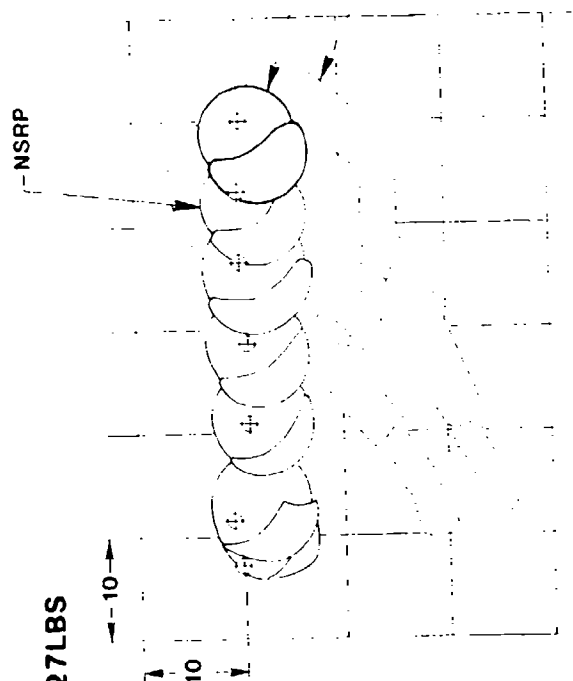
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



— MIL-S-58095(A79-046)

FAILED

DESIGN EYE REF POSITION

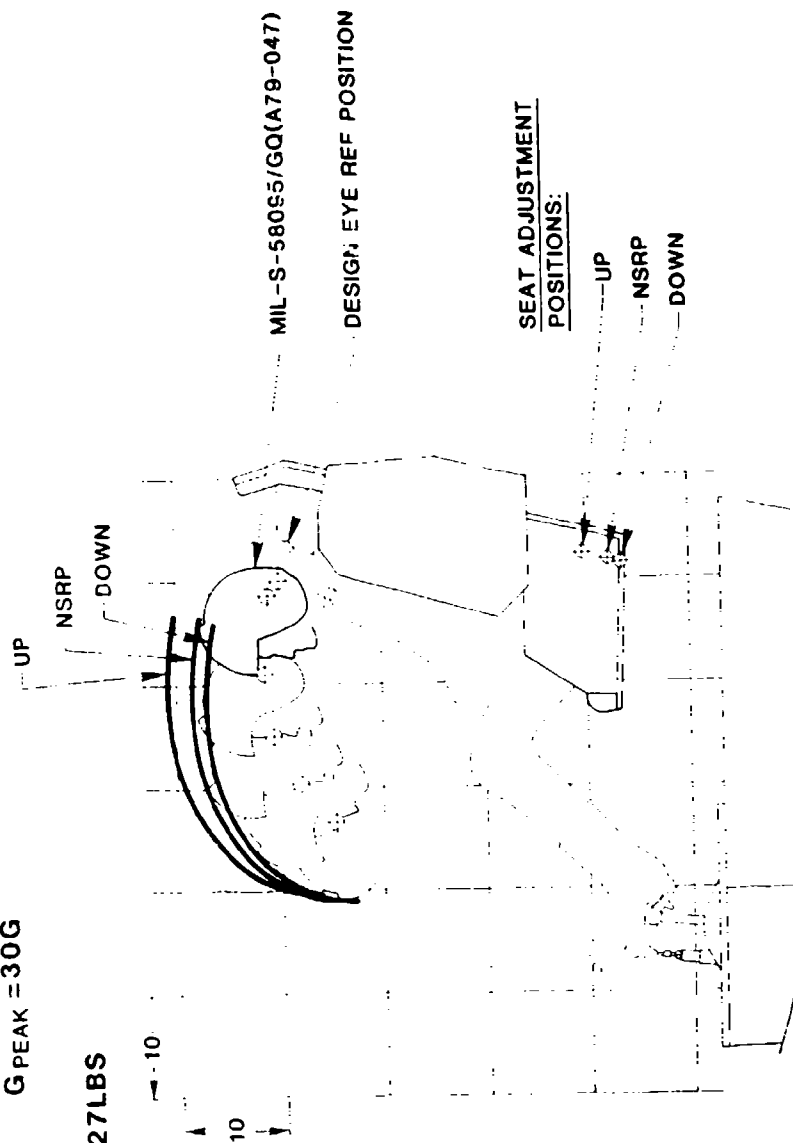
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 30^\circ$

DUMMY: VIP-95, 227LBS



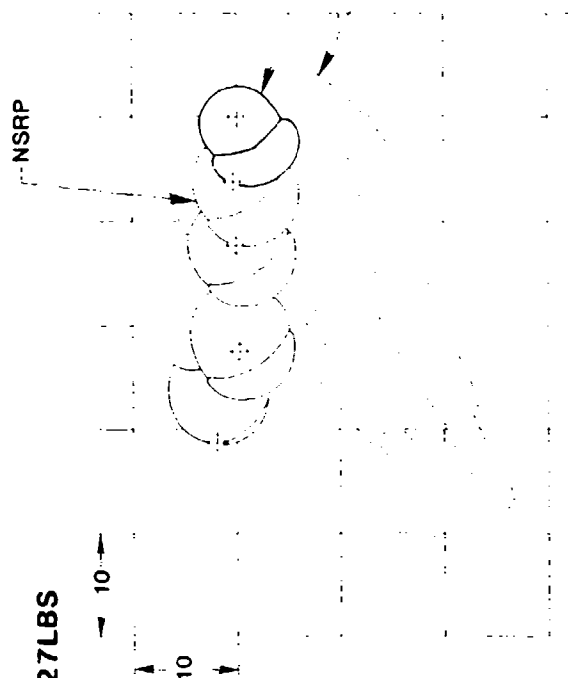
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



MIL-S-58095/GQ(A79-047)

DESIGN EYE REF POSITION

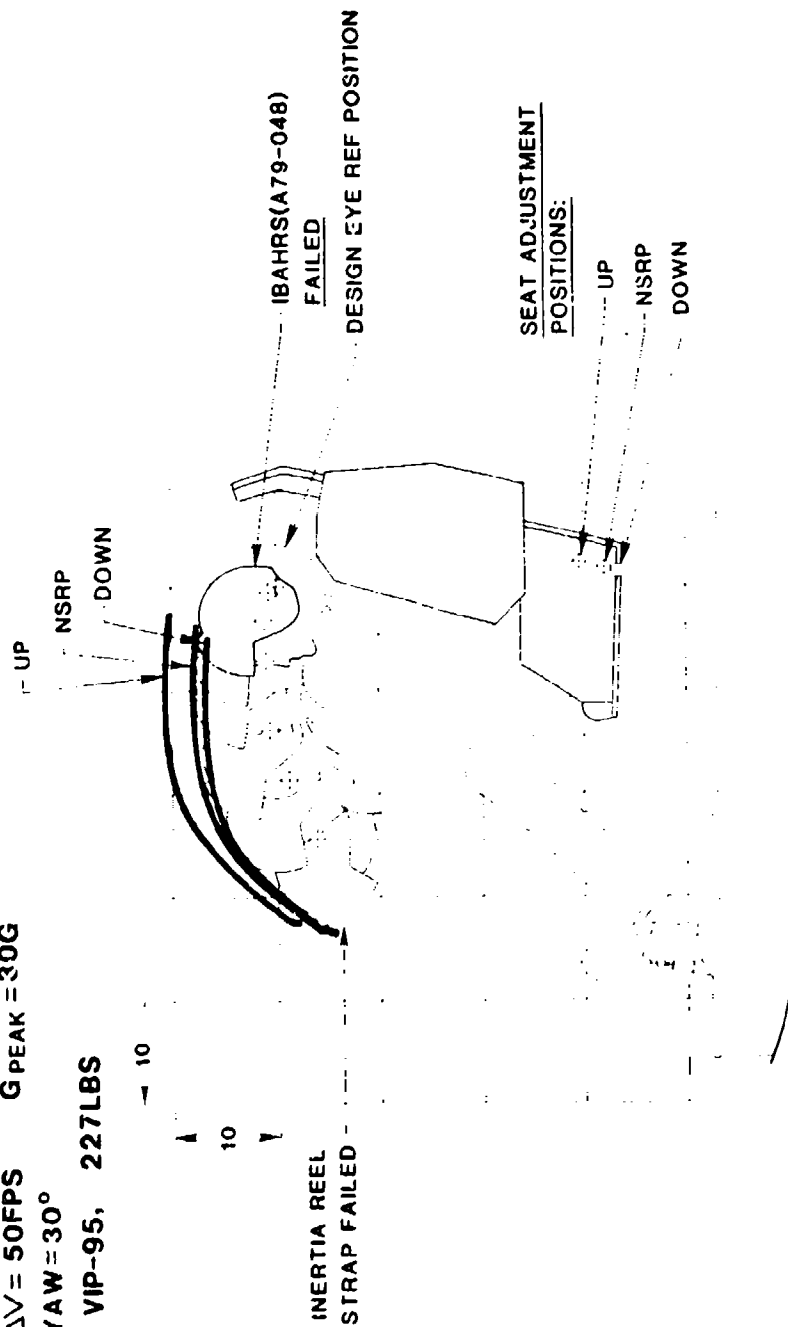
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 30^\circ$

DUMMY: VIP-95, 227LBS



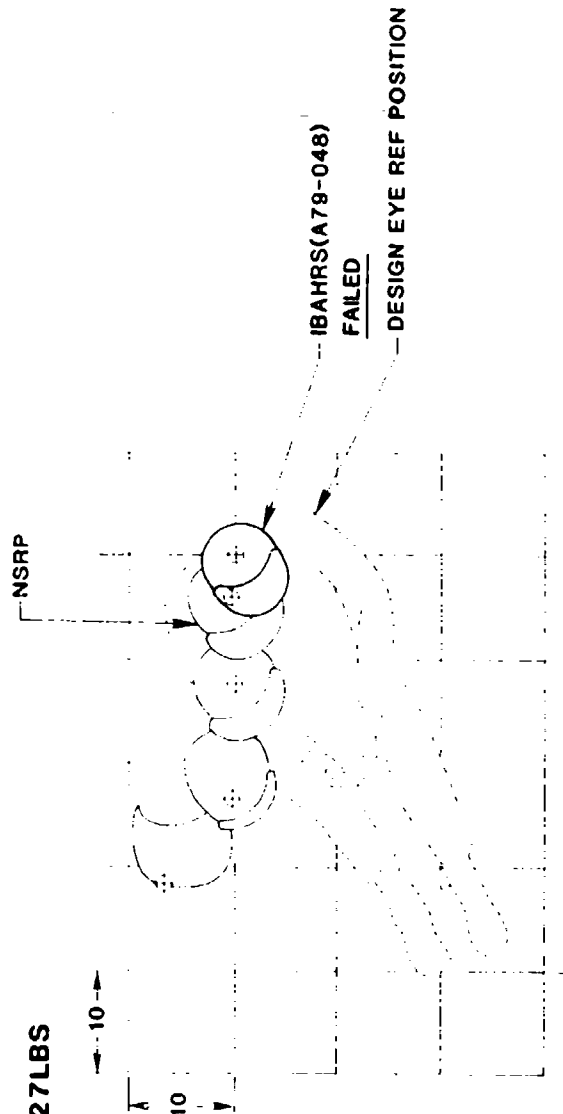
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 30^\circ$

DUMMY: VIP-95, 227LBS



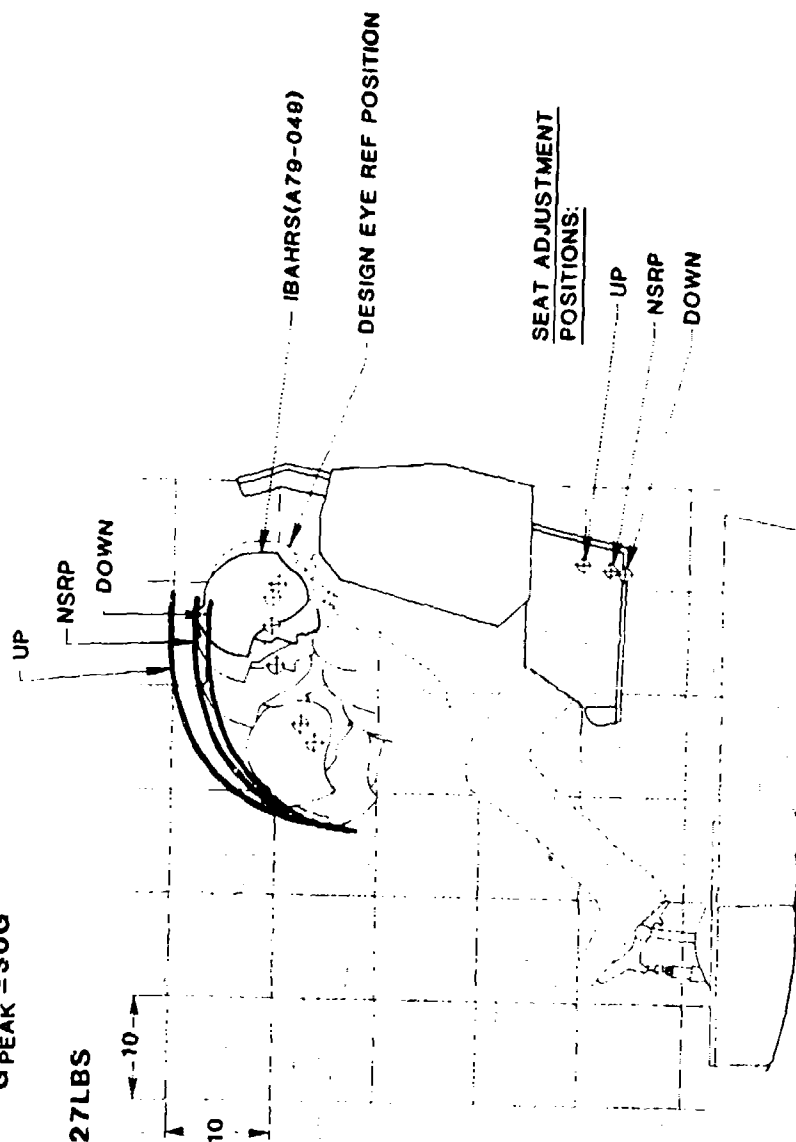
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS



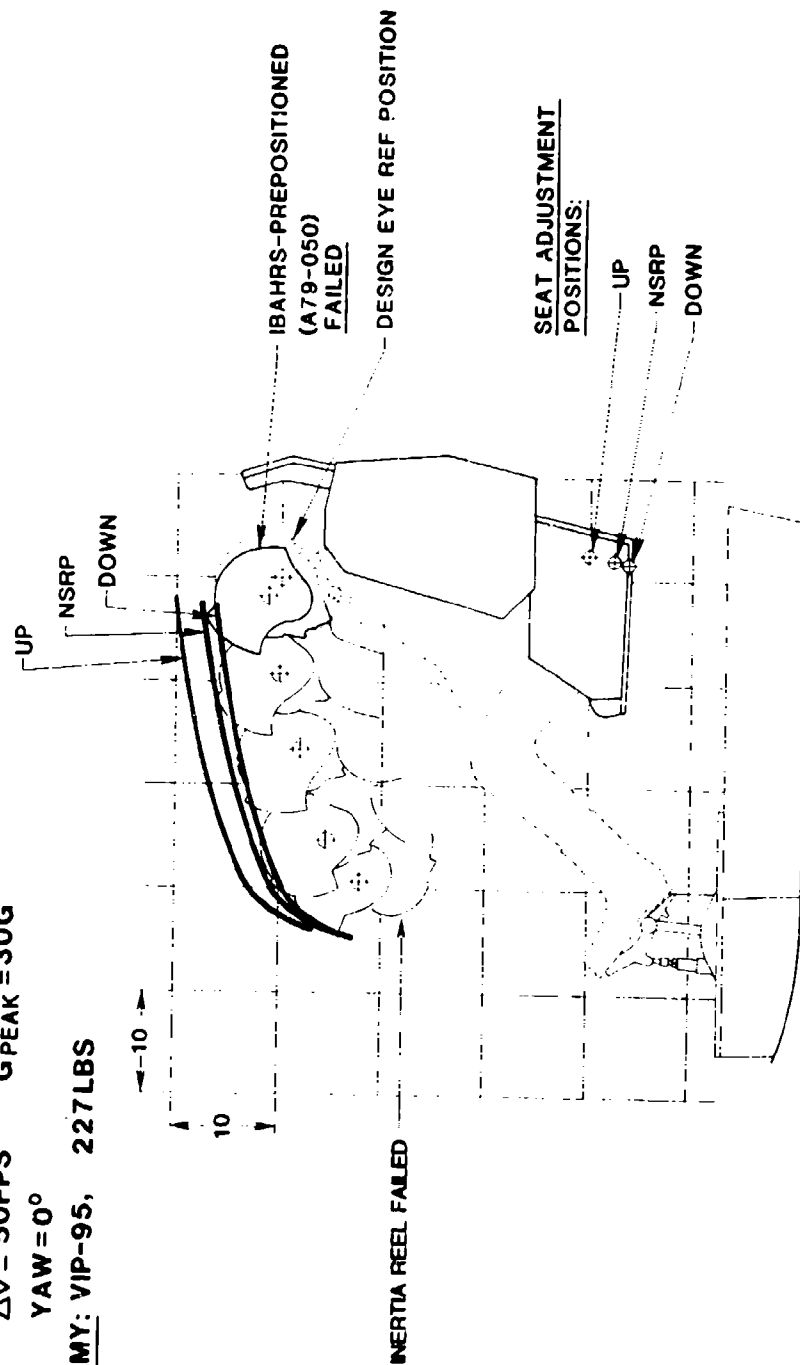
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227 LBS



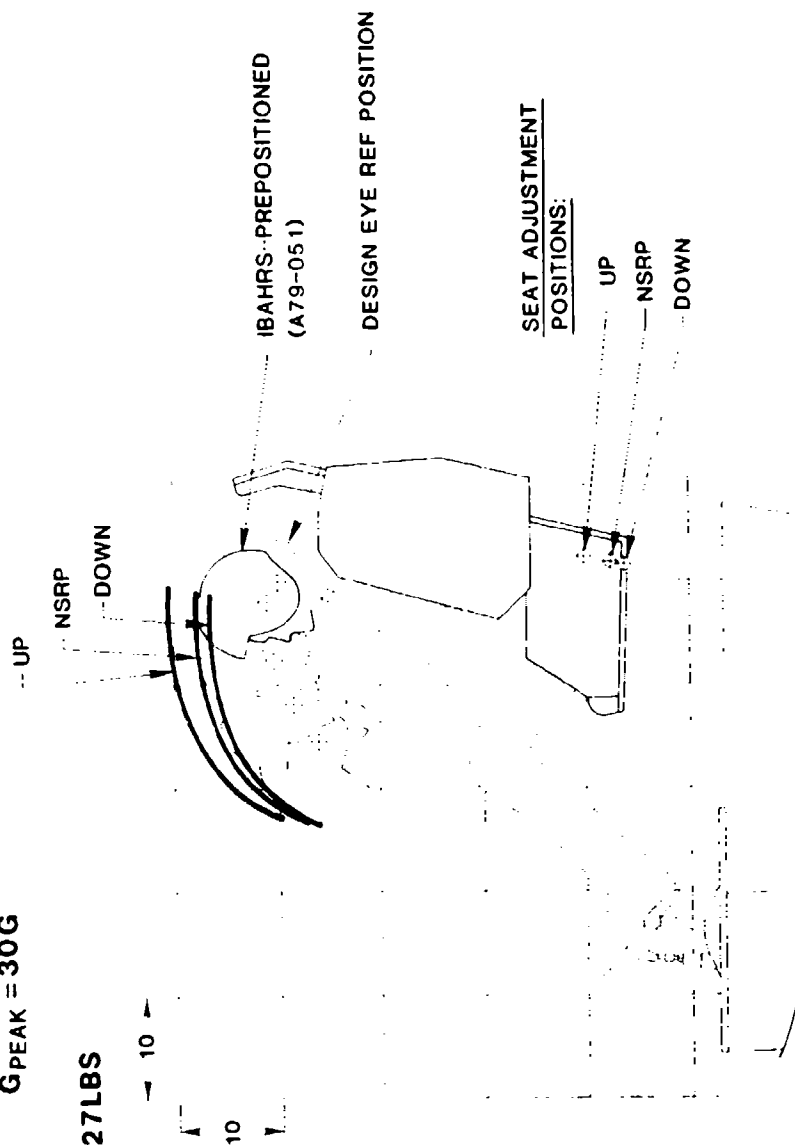
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30 \text{ G}$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



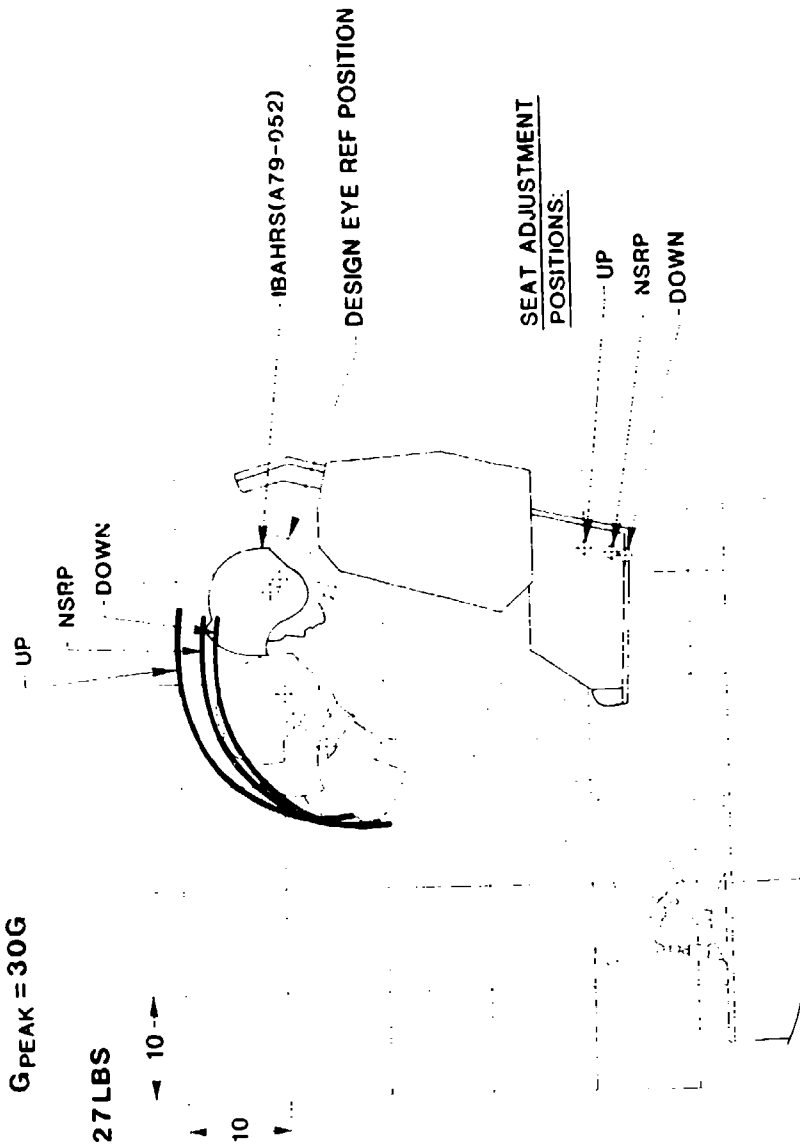
CPG STRIKE ENVELOPE

PULSE: 95th PERCENTILE SURVIVABLE

$\Delta V = 50 \text{ FPS}$ $G_{\text{PEAK}} = 30G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



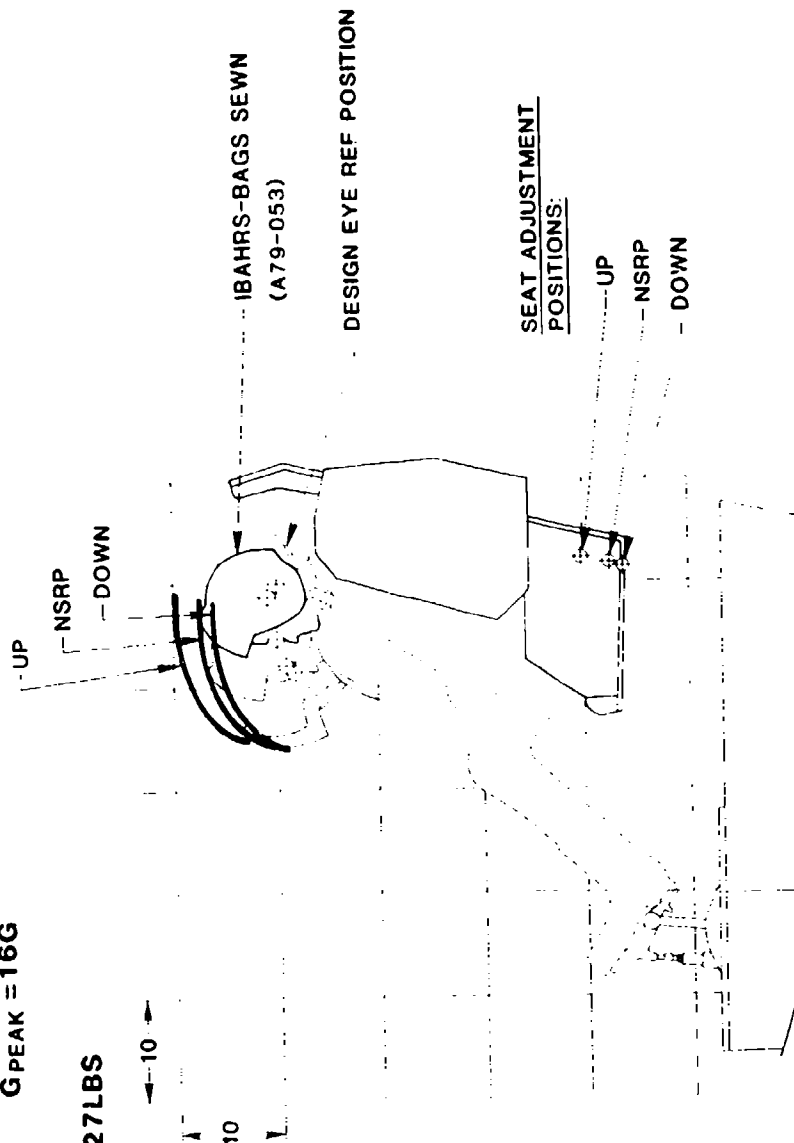
CPG STRIKE ENVELOPE

PULSE: 85th PERCENTILE SURVIVABLE

$\Delta V = 39\text{FPS}$ $G_{\text{PEAK}} = 16G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



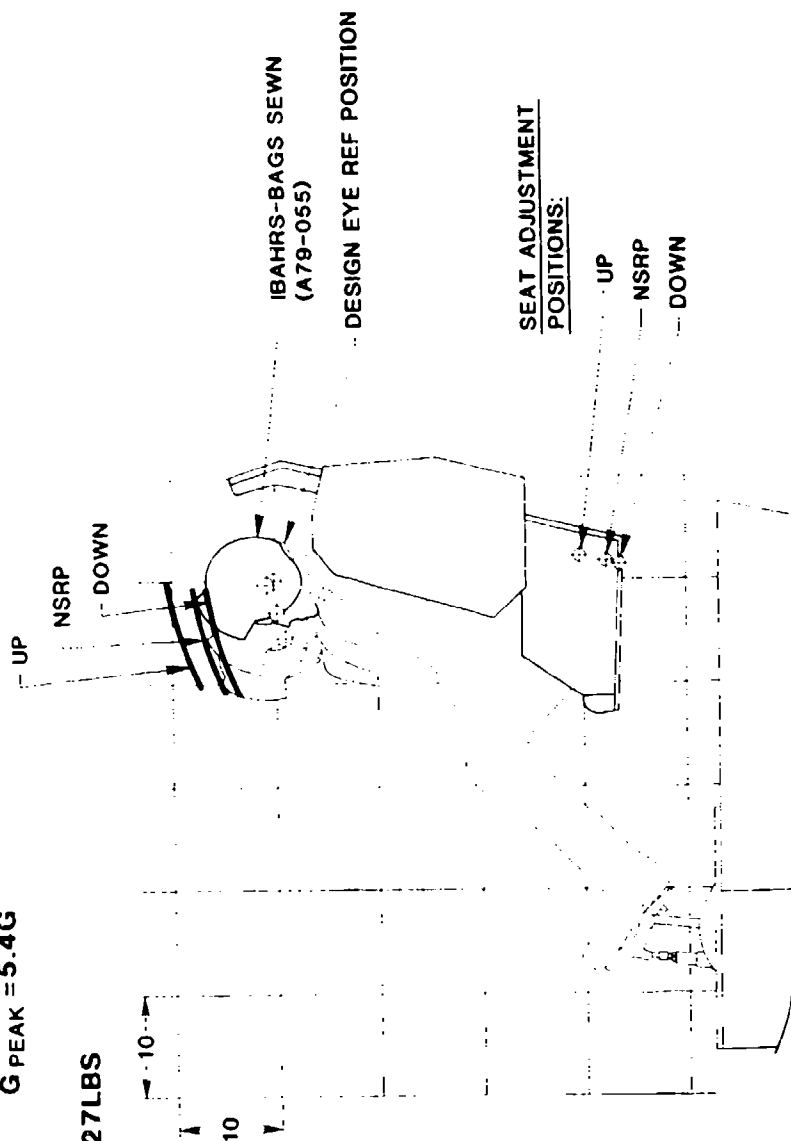
CPG STRIKE ENVELOPE

PULSE: 50th PERCENTILE SURVIVABLE

$\Delta V = 28\text{FPS}$ $G_{\text{PEAK}} = 5.4G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS



CPG STRIKE ENVELOPE

PULSE: 85th PERCENTILE SURVIVABLE

$\Delta V = 39\text{FPS}$ $G_{\text{PEAK}} = 16G$

$YAW = 0^\circ$

DUMMY: VIP-95, 227LBS

UP
NSRP
DOWN

10

10

10

MIL-R-XXX/IBAHRS-
BAGS SEWN(A79-056)

DESIGN EYE REF POSITION

SEAT ADJUSTMENT
POSITIONS:

UP

NSRP

DOWN

CPG STRIKE ENVELOPE

PULSE: 85th PERCENTILE SURVIVABLE

$\Delta V = 39\text{FPS}$ $G_{\text{PEAK}} = 16G$

$\text{YAW} = 0^\circ$

DUMMY: VIP-95, 227LBS

